Exhibit D

FILED
October 16, 2014
INDIANA UTILITY
REGULATORY COMMISSION

STATE OF INDIANA

INDIANA UTILITY REGULATORY COMMISSION

VERIFIED PETITION OF INDIANAPOLIS POWER & LIGHT COMPANY ("IPL"), AN INDIANA CORPORATION, FOR (1) ISSUANCE OF CERTIFICATES OF PUBLIC CONVENIENCE AND NECESSITY AND APPROVAL OF PROJECTS TO COMPLY WITH FEDERALLY MANDATED REQUIREMENTS, INCLUDING THE CONSTRUCTION OF WATER TREATMENT TECHNOLOGIES, OPERATIONAL CHANGES AND USE OF MODIFIED STORMWATER MANAGEMENT PRACTICES AT PETERSBURG AND HARDING STREET GENERATING STATIONS, AND REFUELING OF HARDING STREET STATION UNIT 7 ("COMPLIANCE PROJECT"); (2) FOR ONGOING REVIEW; AND (3) APPROVAL OF ASSOCIATED RATEMAKING AND ACCOUNTING TREATMENT, INCLUDING COST RECOVERY IN ACCORDANCE WITH IND. CODE § 8-1-8.4-7 AND AUTHORITY TO DEFER COSTS UNTIL SUCH COSTS ARE REFLECTED IN RATES	)	**CAUSE NO. 44540**

INDIANAPOLIS POWER AND LIGHT COMPANY'S SUBMISSION OF ITS <u>DIRECT TESTIMONY AND EXHIBITS</u>

Case-In-Chief Volume 3

5. Dennis H. Fink
6. Michael L. Holtsclaw
7. Donald E. Martin
8. Dennis C. Dininger
9. Judah Rose
10. Diane Crockett
11. James L. Cutshaw

VERIFIED DIRECT TESTIMONY

OF

DENNIS H. FINK, CH2M HILL

ON BEHALF OF

INDIANAPOLIS POWER & LIGHT COMPANY

IURC CAUSE NO. 44540

INCLUDING PETITIONER'S ATTACHMENTS DHF-1 through DHF-2

VERIFIED DIRECT TESTIMONY OF DENNIS H. FINK
ON BEHALF OF
INDIANAPOLIS POWER & LIGHT COMPANY

Q1. Please state your name, employer, and business address.

A1. Dennis H. Fink. CH2M HILL Engineers, Inc. (hereinafter "CH2M HILL"). 155 Grand Avenue, Suite 800; Oakland, CA 94612.

Q2. Please describe CH2M HILL and its qualifications and experience with utility environmental compliance studies.

A2. CH2M HILL is a global full -service consulting, design, construction, and operations firm. CH2M HILL has delivered all aspects of wastewater treatment solutions for the Power Industry from study through construction, startup and operation. This includes study through startup support on treatment plants that have been built in the past six years to replace ash ponds, and treatment plants to treat flue gas desulfurization ("FGD") wastewater. This perspective allows our technologist to identify and evaluate compliance options, and our cost estimators to provide our clients with needed cost accuracy and precision through project definition and design.

Q3. What is your position with CH2M HILL?

A3. Senior Project Manager.

Q4. Please describe your duties as a Senior Project Managerfor CH2M HILL.

A4. I lead teams in developing and evaluating alternatives for, and designing treatment facilities needed to, achieve wastewater compliance requirements for our clients.

Q5. Please describe your duties for CH2M HILL on the IPL NPDES compliance project.

A5. I am CH2M HILL's project manager, and am therefore responsible for delivery of our scope of work. In so doing, I led our team of CH2M HILL wastewater technologists, which includes engineers, technical and permitting experts. I was lead author of the NPDES Compliance Strategy Plan ("CSP"), which is provided with this testimony as Attachment DHF-2.

Q6. Please summarize your education, professional background.

A6. M.S., Engineering, University of California at Davis, 1993 and B.S., Engineering, Duke University, 1991. I have worked professionally at CH2M HILL from October 1993 to 2000, and 2001 until the present. I worked for NatureServe from 2000 to 2001 as a project manager. NatureServe is a non-profit conservation organization focused on providing scientific information. My experience has included extensive work for the power industry. This experience began in the late 1990s with work for the Electric Power Research Institute ("EPRI"), American Electric Power ("AEP"), Duke and other utilities characterizing current wastewater streams and building predictive models to understand changes to wastewater caused by changes to a power plant. This work has continued throughout my career. I am currently involved in a leadership role with three other projects similar to our alternatives evaluation work for IPL.

Q7. Have you previously testified before the Indiana Utility Regulatory Commission?

A7. No.

Q8. What is the purpose of your testimony in this proceeding?

A8. My testimony discusses the CH2M HILL analysis that developed the recommended plan to comply with the IPL sites' National Pollutant Discharge Elimination System ("NPDES") permit program, including cost estimating.

Q9. Does your testimony include any attachments?

A9. Yes. My testimony includes Attachment DHF-1, which is a copy of the CH2M HILL-authored NPDES CSP. My testimony also includes Attachment DHF-2, which is a copy of the CH2M HILL-authored memorandum to IPL describing the cost implications of closing or refueling units at the Petersburg Generating Station.

Q10. Were these attachments prepared or assembled by you or under your direction and supervision?

A10. Yes.

Q11. How is the remainder of your testimony organized?

A11. The remainder of my testimony is organized as follows:

II. Environmental regulations
III. Study approach
IV. Discussion of compliance alternatives
V. Study results by station
VI. Description of how the proposed compliance project allows IPL to comply with the NPDES requirements and position for future regulations
VII. Estimated cost of compliance

Q12. What environmental regulations are relevant to your analysis?

A12. The regulatory driver is the NPDES permits issued under Section 402 of the Clean Water Act. IPL Witness Oliger discusses the NPDES requirements.

Q13. Please describe the IPL NPDES permits.

A13. As further discussed by IPL Witness Oliger, renewed NPDES permits were issued to Petersburg, Eagle Valley, and Harding Street Generating Stations in 2012. The permits include limits on several parameters associated with the stations' Outfalls (an outfall is the discharge point of a wastewater stream into a body of water). Of primary concern because they require changes to wastewater management to ensure reliable compliance, are Petersburg Outfalls 001 and 007, and Harding Street Outfall 006. The IPL NPDES permits became effective on October 1, 2012. These permits contain technology based effluent limits ("TBELs") and new water quality based effluent limits ("WQBELs") for both Harding Street and Petersburg Generating Stations and non-numeric Stormwater effluent limits for all three IPL Generating Stations. The compliance date for the new non-numeric Stormwater and total residual chlorine ("TRC") (Petersburg only) effluent limits is October 1, 2013.

The permits initially set WQBEL compliance date as October 1, 2015. Per Agreed Orders, issued on April 29, 2013, the new metal WQBELs compliance date for the Petersburg and Harding Street Generating Stations is September 29, 2017. This schedule modification was granted by IDEM after IPL requested the extension based on IPL input and CH2M HILL experience with the time needed to select, permit, procure, construct and startup a wastewater treatment system of the magnitude and complexity needed to meet the limits.

Q14. What are the discharge limits in the NPDES permits?

A14. The discharge limits in the NPDES permits are based on water quality of the receiving waterbody. Prior to the issuance of the current NPDES permits, IPL was required to monitor and report discharge parameters including but not limited to mercury, selenium, boron, and sulfate. During the permit renewal process, the Indiana Department of Environmental Management ("IDEM") reviewed the discharge monitoring reports' effluent (discharged water) data and determined that discharges from the generating stations have the reasonable potential to cause, or contribute to, an exceedance (termed "reasonable potential to exceed" or "RPE") above the allowable concentration of the State's water quality standards including State narrative criteria for water quality. As a result of the RPE analysis, the IDEM established WQBELs to ensure compliance with the State's water quality standards. IDEM's RPE analysis process utilized procedures established under the Clean Water Act and subsequently incorporated into Indiana environmental rules. Both the Harding Street and Petersburg Generating Stations discharge to creeks with zero or near zero low-flow conditions; therefore, water quality limits are very low. The current wastewater discharge from Harding Street's Outfall 006 and Petersburg's Outfall 001 have been measured at levels of parameters that exceed these permit WQBELs which go into effect in 2017. Therefore treatment of the wastewater streams flowing to these outfalls is required.

Q15. What IPL facilities are subject to NPDES compliance?

A15. All sites with a point source discharge of a regulated pollutant are subject to NPDES compliance. The sites evaluated in this study were IPL's Harding Street, Petersburg, and Eagle Valley Generating Stations. An issued NPDES permit may need to be modified if any of the actions included in 327 IAC 5-2-16, 5-2-8(10)(F), and/or 327 IAC 2-1.3 are triggered. For example, if Harding Street is refueled to be gas-fired it would materially change that station's wastewater, and the permit would need to be modified.

Q16. Do other regulations require a change in IPL's water and wastewater management?

A16. In addition to the current NPDES permit limits, anticipated regulatory drivers were considered in the context of choosing a NPDES compliance strategy that would be adaptable to future regulations. These regulations include but are not limited to: changes to the NPDES permit limits, update to the industry's Effluent Limitation Guidelines ("ELGs") under the Clean Water Act, and the Coal Combustion Residuals ("CCR") Rule. Other regulations are anticipated and these matters are discussed in IPL Witness Oliger's testimony.

Q17. Are the NPDES permit limits subject to change in the future?

A17. Yes. The current NPDES permits include several parameters that IPL must monitor (sample and analyze the concentration) and report to IDEM based on the current facilities' wastewater streams. IDEM typically includes reporting requirements to determine if these parameters should have limits in future permits. In the Harding Street Generating Station permit, the ash pond discharge (Outfall 006) has such "monitor and report" requirements on: aluminum, ammonia, arsenic, boron, cadmium, chlorides, chromium, lead, manganese, mercury, nickel, phosphorus, selenium, sulfate, total dissolved solids ("TDS"), and zinc. In the Petersburg Generating Station permit, the ash pond discharge (Outfall 001) has such "monitor and report" requirements on: ammonia, arsenic, boron, biochemical oxygen demand ("BOD"), cadmium, chlorides, cyanide, fluoride, lead, manganese, mercury, nickel, phosphorus, selenium, sulfate, and TDS. Boron is notable because it has no commercially proven treatment method that would achieve future potential limits at the two generating stations. In addition, Indiana is required through federal regulation under the Clean Water Act and incorporated into subsequent state regulation, to review water quality criteria on a periodic basis in order to verify that existing water quality criteria protect the designated use(s) (numeric and narrative) of a waterbody. If IDEM determines a criteria value is not sufficient to ensure adequate protection of a corresponding waterbody, such criteria may be revised which may result in revised WQBELs.

Q18. What was CH2M HILL's assignment in this case?

A18. CH2M HILL performed a study that evaluated and recommended a plan to comply with the sites' NPDES permit requirements. The study, titled the NPDES CSP, is included with my testimony as Petitioner's Attachment DHF-1.

Q19. Please describe the CH2M HILL NPDES CSP in Attachment DHF-1.

A19. This plan documents the selected compliance strategy for each of the three generating stations, and the evaluation method used to reach that selection.

Q20. Please describe the process CH2M HI LL used to evaluate the various control options and the costs and performance expectations associated with these water and wastewater management technologies when applied to IPL's facilities.

A20. CH2M HILL worked with IPL in the evaluation and selection of the compliance strategy using the following steps:

1. Set evaluation criteria and goals.

2. Develop basis of design.

3. Evaluate compliance strategy alternatives, first by determining the best overall approach, then screening down to a few alternatives, and then doing further evaluation of this short list.

This evaluation process requires significant site-specific considerations be evaluated. IPL began the process to procure support for the evaluation in the spring of 2012. CH2M HILL was selected to support IPL, and CH2M HILL's evaluation began in September 2012. The evaluation requires significant time (i.e., over one year) to: gather information over the range of station operating conditions needed to set the basis of design, evaluate proven and unproven control technologies to balance their costs and risks of compliance, evaluate possible regulatory relief options with regulators (such as relocating the stations' outfalls to larger receiving bodies), and conduct treatability testing. The treatability testing included biological treatment which takes several months to test. The pilot test field work was conducted from June to November 2013, with planning taking several months before that.

Q21. What evaluation criteria (Step #1) were used in your analysis to determine which compliance approach to be used at IPL generating facilities to achieve NPDES compliance?

A21. The following evaluation criteria were used:

Technical Feasibility

Cost (capital, operating, and net present value)

Risk of non compliance with NPDES permit discharge limits

Adaptability to obtain compliance with future requirements

Risk of operations reliability problems in the treatment system or operational impacts on power production

Land requirements

Q22. Why was adaptability an important evaluation criterion?

A22. Adaptability is the ability of a treatment process to handle changes in plant operations or future regulatory requirements with little or no modifications to equipment or processes. An alternative that had low adaptability would have little ability to comply with future changes and would need to be replaced by a new process, resulting in costs for equipment that must be replaced with new treatment equipment. For instance, installation of a FGD wastewater biological treatment system (such as would be done to meet a selenium limit) would not be adaptable if a future limit requires removal of chlorides, as chlorides are not well removed by biological treatment. If a new thermal Zero Liquid Discharge ("ZLD") system were required to meet the chloride limit, the biological treatment system would become obsolete.

Q23. What were the goals (Step #1) of the NPDES compliance evaluation and selection?

A23. The goal was to determine a compliance plan with low risk of non-compliance with the new NPDES requirements and with adaptability to other potential future requirements at the lowest reasonable cost, including detailed plans for wastewater management, reuse, and treatment. The project goals also included recommending general timing associated with control installations, taking into account upcoming additional wastewater management requirements of pending regulations.

Q24. What is the basis of design (Step #2)?

A24. The basis of design consists of:

Current wastewater management

Wastewater flows (measured in gallons per day)

Limits on pollutant concentration in the station's wastewater discharges

Projected water quality of regulated wastewater, including a determination of which pollutants need treatment and are therefore considered compliance gaps in current wastewater management.

This evaluation of flows and water quality was done starting from the stations' current wastewater, and then also included estimating the flows and water quality as the stations implement currently ongoing environmental projects, such as changes to comply w ith the Mercury and Air Toxics Standards ("MATS").

Q25. How do the IPL generating stations currently manage wastewater?

A25. Most wastewater streams generated at the stations are managed in ponds. These wastewater streams include FGD wastewater, ash transport water (water used to transport coal ash from the power plant to ponds), cooling tower blowdown (blowdown is the small wastewater stream that purges scaling (hardness) salts from the system that would otherwise hamper operations), and numerous other plant wastewaters. The ponds provide an area for particulate material to settle out, before water is discharged to a receiving waterbody. Both Harding Street and Petersburg Generating Stations discharge to a small creek, each is called Lick Creek, although they are different creeks.

Q26. How were wastewater flows estimated?

A26. In developing the basis of design, CH2M HILL reviewed and used water flow and quality composition data IPL had from prior work, as well as collected additional information and wastewater samples to fill data gaps (missing information) in the pre -existing data. This prior work included a water management study performed by General Electric in

2011 for the Petersburg and Harding Street Generating Stations. The basis of design flow rates are provided in Appendices B and C of the CH2M HILL NPDES CSP (Attachment DHF-1).

Q27. What assumptions were used about IPL operating units in setting the basis of design?

A27. CH2M HILL made assumptions about the operation of the generating stations to guide the development of the design basis. For Harding Street Generating Station, it was assumed that Units 3 and 4 are retired and Units 5 and 6 will be taken off -line or converted to natural gas before the 2017 compliance deadline of the NPDES permit. For Petersburg Generating Station, it was assumed that operation of Units 1, 2, 3, and 4 will continue unchanged. For Eagle Valley Generating Station, it was assumed that the oil and coal-fired units will be retired prior to 2017. The new planned combined cycle gas turbine ("CCGT") station at Eagle Valley was not considered during this project because CCGT operation was not addressed in the 2012 NPDES Permit Renewals. IDEM will address any potential requirements related to the CCGT through a separate future permitting action.

Q28. Did CH2M HILL also consider alternative operations scenarios?

A28. Yes. We prepared a compliance strategy for a scenario in which Harding Street Generating Station's Unit 7 (in addition to the assumptions described above) was also converted to natural gas.

Q29. What are the limits on pollutant concentration in the stations' wastewater discharges?

A29. The permit limits are summarized in Section 2.1 (Harding Street), Section 2.2 (Petersburg), and Section 2.3 (Eagle Valley) of the NPDES CSP (Attachment DHF-1).

Q30. How did CH2M HILL determine which pollutants would require management to provide for reliable compliance with the NPDES permit limits?

A30. In developing the basis of design, CH2M HILL used wastewater flow and quality information IPL had from prior work, as well as collecting additional information and wastewater samples to fill gaps in the pre-existing data. The basis of design projected parameters requiring treatment. CH2M HILL reviewed the historical monitoring IPL has done of its discharge to determine which pollutants would need to be managed to consistently achieve compliance with the NPDES permit limits. Parameters that have had concentrations higher than the permits' limits in some samples were flagged as needing management. Corresponding stages of the overall process is described in the NPDES CSP Appendix B Table 3 and Appendix C Tables 3 and 4 (Attachment DHF-1).

Q31. What pollutants were projected to require management beyond current treatment to provide for consistent compliance with the NPDES permit limits?

A31. For Harding Street Generating Station Outfall 006, if the station continues to use coal these pollutants are: cadmium, mercury, iron, and selenium. If Harding Street is refueled to natural gas and the ash pond closed, these pollutants are total suspended solids ("TSS") and mercury. For Petersburg Generating Station Outfall 001 (ash pond), these pollutants are: TSS, cadmium, copper, iron, lead, mercury, nickel, selenium, sulfate, zinc, and total residual chlorine. For Petersburg Generating Station Outfall 007 (CCR runoff), these pollutants are: TSS, boron, mercury, and sulfate. It should be noted that most of these results above limits are for limits that will become effective in 2017. The pollutants that drive the selection of treatment processes are summarized in Table DF-1 below.

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Q32. In what form do these pollutants exist in IPL wastewater?

A32. Power plant wastewater contains pollutants that are present in solution and as particles. Think of it as making coffee. The coffee grounds are particles. If you add sugar and coffee grounds to hot water, you can remove the coffee grounds by passing the water through a coffee filter. The sugar is dissolved and passes through the filter, but the grounds are particles and are removed. If you put the mixture of water, grounds, and sugar in a coffee cup, the grounds settle to the bottom and the sugar stays dissolved.

Similarly, pollutants in power plant wastewater can be present as dissolved or particles. The particles can be settled out, like the coffee grounds in a coffee cup, or filtered out. Dissolved pollutants can be removed if they are turned into particles, a nd then allowed to settle out or filtered like the coffee grounds. Sugar can be removed from coffee if the water is boiled off, leaving the crystals of sugar and coffee. Treatment is all about turning dissolved pollutants into particulate pollutants, and then removing the particulates.

Q33. What is the source of the pollutants projected by CH2M HILL to require management in order to provide for consistent compliance with the NPDES permit limits?

A33. In coal-fired power plants, the pollutant sources are typically coal, air used in combusting the coal, limestone, source water, and material contacted by precipitation runoff. Coal is generally the largest of these sources for most pollutants. Coal's trace compounds separate out in the boiler into ash and air emissions (flue gas). Some of the trace compounds in the flue gas are removed by FGD systems. The systems use a slurry of pulverized limestone and water to react with the flue gas to remove sulfur dioxide (and other acid gases), forming solid particles of calcium sulfate (gypsum, which is used in manufacturing wall board). A portion of the system water must be removed or purged (wasted) to control the buildup of chlorides (which are corrosive to metal such as in the scrubber equipment), as well as fine solid materials formed in the systems.

Q34. Did IPL consider relocating their main discharge (Harding Street Outfall 006 and Petersburg Outfalls 001 and 007) from the small receiving water bodies to larger water bodies as a means to potentially receive higher discharge limits and thereby potentially require less costly wastewater management changes?

A34. Yes. Relocating discharges to the White River was evaluated for both the Harding Street and Petersburg Generating Stations. The White River has a substantially higher flow rate than the current receiving waterbodies (Lick Creek at each site), which may provide some relief from certain WQBELs, which are limits set based on the water quality in the water body receiving the discharge. However, discharge relocation will not affect compliance with technology -based limits (limits set based on how well existing technologies can remove pollutants; these limits are set by the Steam Electric ELGs). The project team evaluated the relocation of combined or individual wastewater streams to the White River by calculating the projected quality of the effluent (or discharged water) and comparing these values with the WQBELs. I discuss the results of this evaluation below.

Q35. Please describe how a compliance strategy was determined for compliance with Stormwater management requirements of the NPDES permits.

A35. IPL evaluated compliance with Stormwater monitoring and non-numeric effluent standards associated with NPDES Permit Conditions I.D and I.E in Section D. The evaluation included existing Stormwater structural and non-structural controls including Best Management Practices ("BMPs"), housekeeping measures related to exposure areas which may be a source of pollutants, current site conditions including maintenance records, inspections, training, and existing Stormwater Pollution Prevention Plans ("SWPPP"). IPL determined a set of controls to be implemented, and discussed these with CH2M HILL. CH2M HILL agreed with these planned controls. CH2M HILL then incorporated these selected controls into the NPDES CSP.

Q36. How was the overall approach selected (Step #3) for water management to comply with NPDES limits?

A36. CH2M HILL developed an overall approach by evaluating which waste streams should be treated and which should be eliminated at the source. An example of source elimination is transporting fly ash pneumatically (with air) to a transfer station and truck loading, rather than moving fly ash with water to ponds for final disposal. CH2M HILL also evaluated what wastewater streams could be treated together, and which would be best treated separately.

Q37. What streams were determined to be best treated separately?

A37. Power plants produce three different types of wastewater streams: ash transport water, FGD water, and Other Waters (consisting of various "low-volume wastewater," "cooling tower blowdown," "coal-pile run-off", Stormwater runoff, and "non-chemical metal cleaning wastewater" streams). These three types of wastewater streams have significantly different flows and characteristics, making it efficient to treat them separately. In addition, the current drafts of upcoming power plant wastewater regulations (the ELGs) contain proposed requirements that some waste streams be treated separately and comply with limits before mixing with other types of waters. A treatment system that is based on combined treatment is not adaptable to these expected upcoming regulations. Therefore, it was determined that these three groups of wastewater streams should be treated separately.

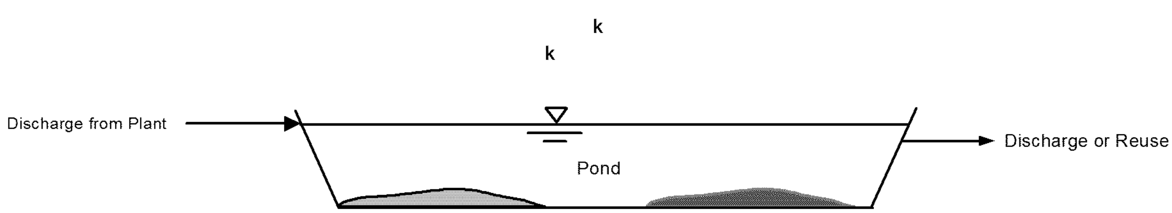
At Petersburg Generating Station, a fourth wastewater group was considered – those flows going to a separate regulated wastewater outfall (007) that also has strict metals limits. The wastewaters going to this outfall are precipitation runoff (rain water) that has contacted process materials (such as a storage pile of solids produced in the scrubber). This wastewater has different characteristics (flow and pollutants) from the other three groups. And the waters going into Outfall 007 are generated in an area several hundred feet away from the station.

Q38. Please summarize the technologies evaluated for NPDES compliance.

A38. The technologies evaluated included: pond treatment, enhanced pond treatment, tank-based physical (including Closed-loop Bottom Ash sluicing using remote drag chain dewatering systems) or physical/chemical treatment, dry fly ash handling, passive biological treatment (downstream of pond or physical/chemical treatment), tank-based biological treatment (downstream of pond or physical/chemical treatment), zero valent iron ("ZVI"), thermal ZLD, and ZLD by reuse. Additional description of each of these technologies is provided below.

Q39. Please describe treatment by pond.

A39. This compliance option means that IPL would continue to treat wastewater in ponds as is currently done. The concept of treatment by pond, in which solids settle out in a pond, is illustrated in Figure 1.



Q40. Please describe treatment by enhanced pond.

A40. This compliance option means that IPL would treat wastewater in ponds, but would add a chemical feed system and mix tanks to convert some soluble (dissolved) or small particulate metals into larger solids that will be removed in the ponds. A liner may be required if the enhanced pond is installed over existing ponds. The concept of this treatment mechanism is illustrated in Figure 2.

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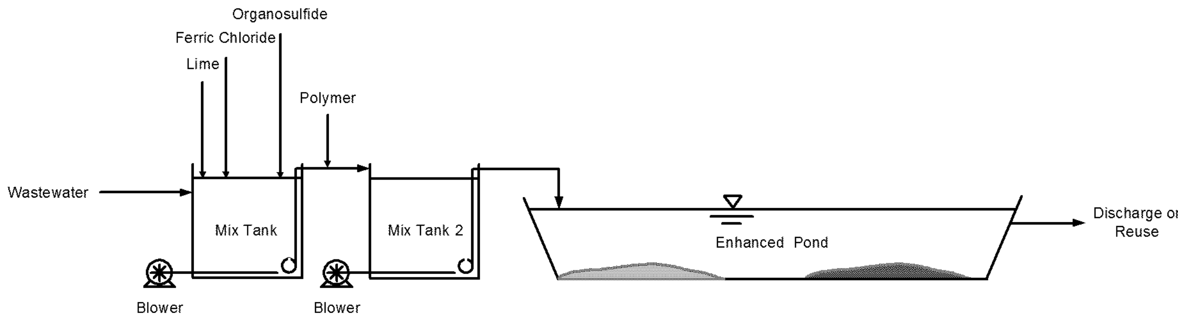

Q41. Please describe treatment by tank-based physical or physical/chemical treatment.

A41. This compliance option would require construction of a treatment plant with physical liquid/solid separation such as in a clarifier (a large tank that provides an area for solids to settle out of the water). The process may also include a filter for additional solids removal. The solids rem oved are subsequently dewatered (squeezed in a filter press to remove some of the water) so the solids can be disposed of as a solid waste. The process may include chemical feed systems and mix tanks to help the removal of dissolved pollutants by converti ng them to solids. The concept of this treatment mechanism is illustrated in Figure 3.

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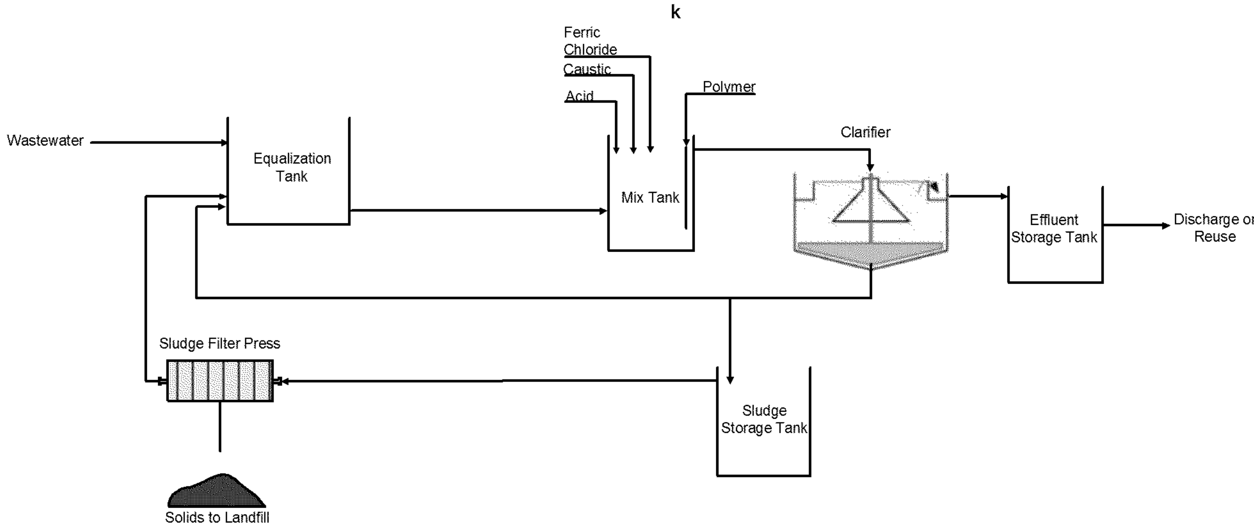

Q42. Please describe dry fly ash handling.

A42. Dry fly ash handling eliminates discharge of fly ash transport water through use of vacuum and/or pressure dry fly ash transport systems.

Q43. Please describe treatment by passive biological treatment (downstream of pond or physical/chemical treatment).

A43. Treatment by passive biological treatment means construct a system that consists of lined, in-ground basins. Water first flows through physical/chemical treatment (shown above in Figure 3) to remove most solids and some metals. These lined, in-ground basins are termed biological reactors. The reactors are filled with organic material (such as wood chips or composted hay). The systems may also use a supplemental liquid carbon source feed system, if needed. Bacterial processes in the reactors are used to convert selenate (a form of selenium present in soluble form and typically not removed by physical or physical/chemical processes) to a solid which can be removed. The system may also help treat other pollutants. The concept of this treatment mechanism is illustrated in Figure 4.

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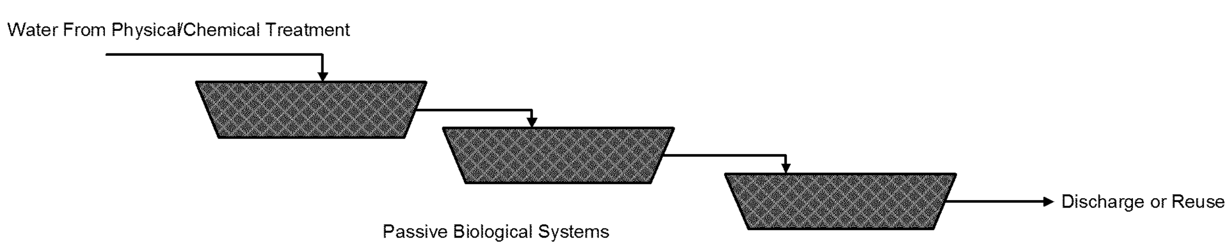

Q44. Please describe tank-based biological treatment (downstream of pond or physical/chemical treatment).

A44. Tank-based biological treatment means the system includes a treatment plant with chemical feed system (for carbon source for bacteria growth) and tank-based bioreactor with similar bacterial process as described in the passive biological system above. Water first flows through physical/chemical treatment (shown in Figure 3) to remove most solids and some metals. The biological treatment system would generate a solid waste containing the removed selenium and biological growth (from the bacterial process); these solids would be dewatered using the same equipment as the physical/chemical system. The system may also help treat other pollutants. The concept of this treatment mechanism is illustrated in Figure 5.

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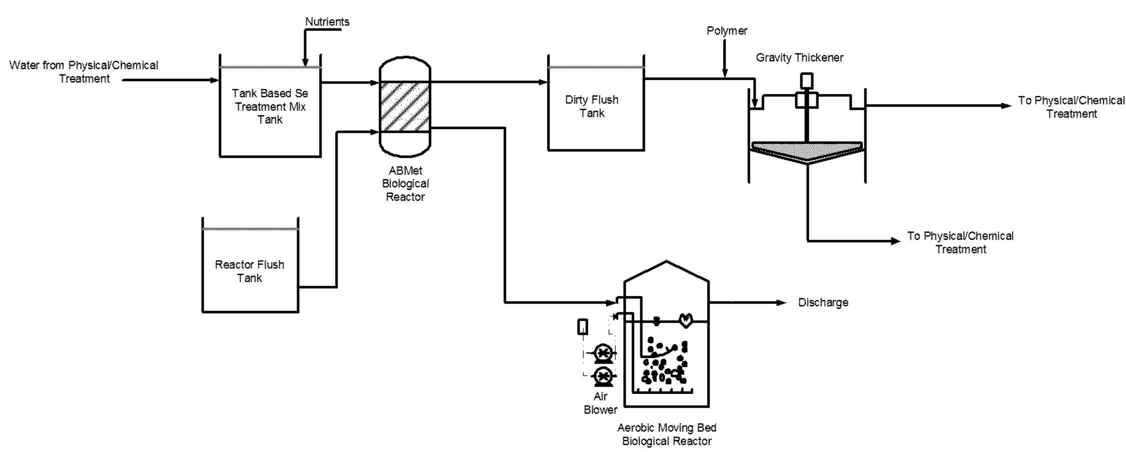

Q45. Please describe treatment by Zero Valent Iron ("ZVI").

A45. Treatment by ZVI means construct a treatment plant with chemical mix tanks, clarifiers, dewatering (filter press). ZVI reacts with trace pollutants, including selenite and selenate, to form particulates that are then removed from the water. Bench-scale testing was done by a ZVI vendor with IPL's FGD water. Results were not favorable because nitrate was converted to ammonia in the chemical reaction at levels that would most likely be non-compliant with discharge limits on ammonia and/or toxicity. In addition, the technology is in the process of being tested on a limited pilot-scale basis. The concept of this treatment mechanism is illustrated in Figure 6.

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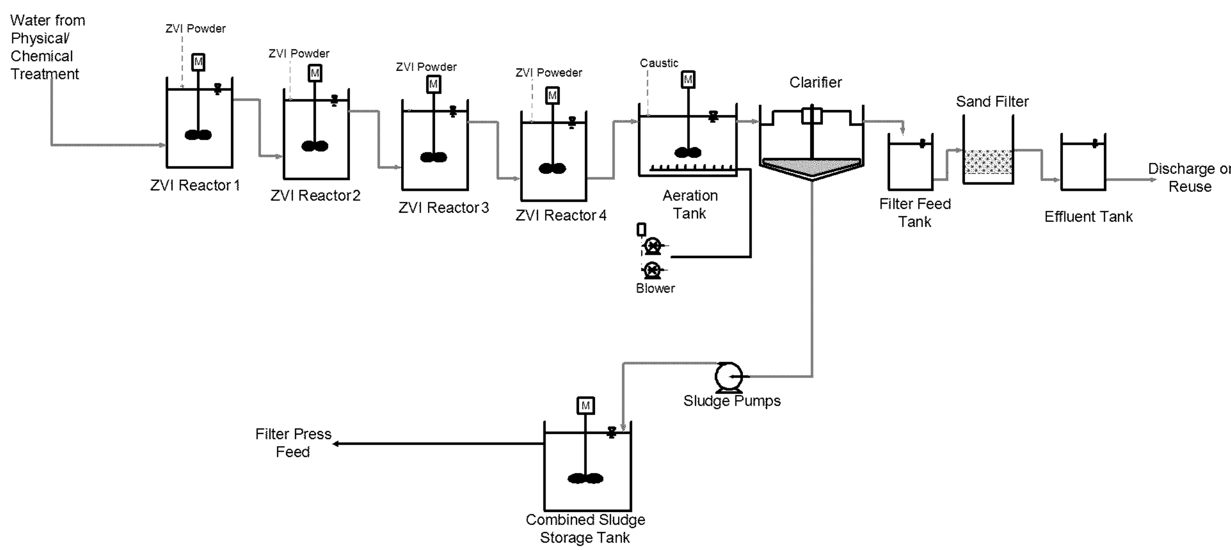

Q46. Please describe treatment by thermal ZLD.

A46. ZLD uses electric power and/or steam to distill off water. Two levels of ZLD systems were evaluated: an evaporator that produces a brine (which can be disposed of by using it for wetting fly ash), and an evaporator plus a crystallizer, which further reduces the evaporator brine to a salt cake. This option would likely require first softening the water (adding lime to remove magnesium and sulfate, which results in reducing the volume of evaporator brine and protecting the evaporator from magnesium hydroxide scale which could hinder the operation of the evaporator, leading to frequent downtime for maintenance). The concept of this treatment mechanism is illustrated in Figure 7.

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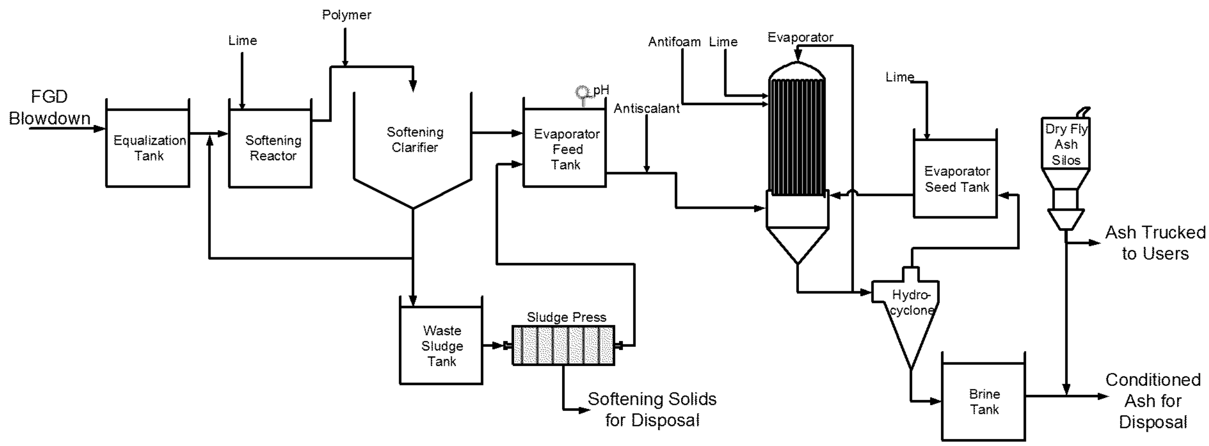
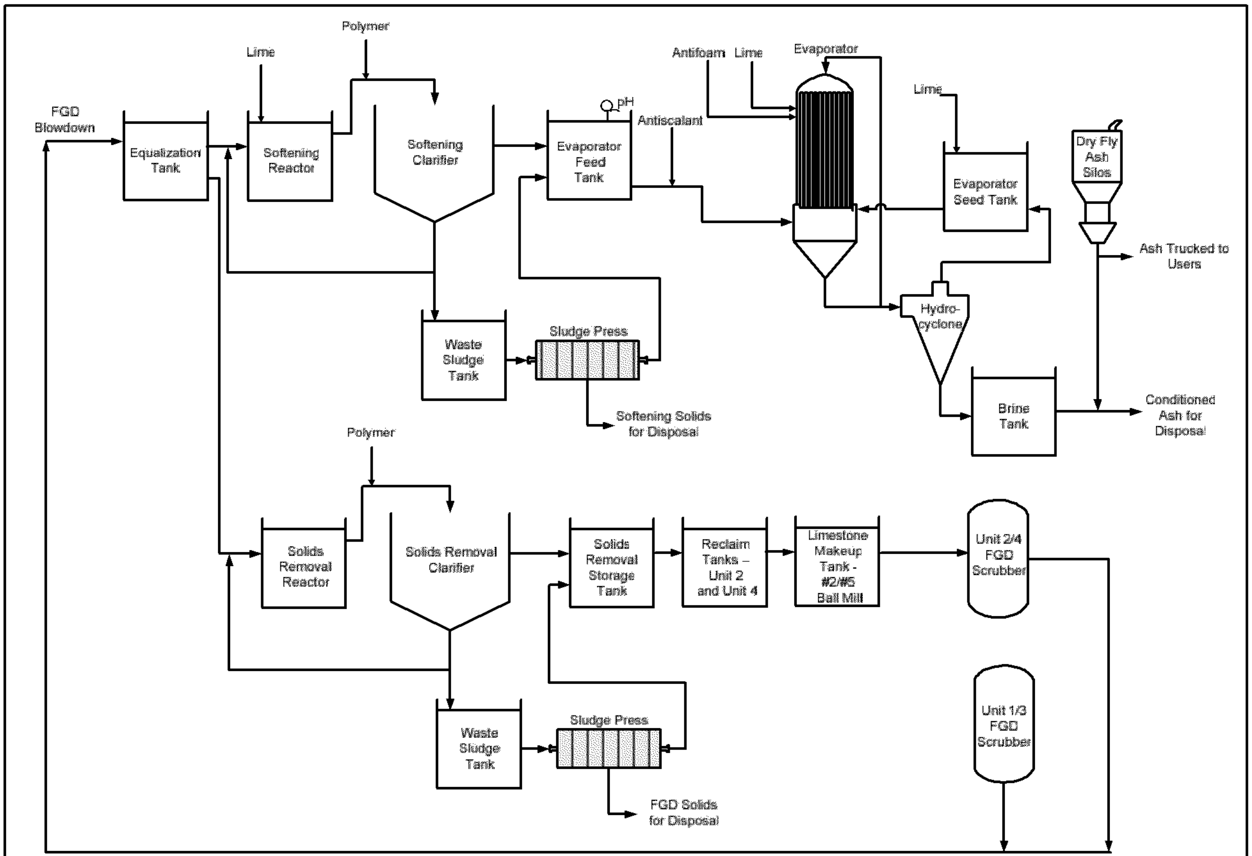


Q47. Please describe ZLD of FGD water using a recycle approach.

A47. The thermal ZLD option was refined during the project to include recycling a portion of the FGD water, which lowered the cost of this option. The flow of FGD system blowdown (blowdown is the small wastewater stream that purges scaling (hardness) salts from the system that would otherwise hamper operations) at both the Harding Street [if firing coal] and Petersburg Generating Stations is driven by fine solids content, rather than chlorides (which is often the driver for setting blowdown flow, to help prevent equipment corrosion). A "ZLD with Recycle" approach was developed in which blowdown is split into two streams: a portion of the FGD wastewater is treated by physical/chemical treatment (clarifier) and then recycled t o the FGD system. A smaller portion of FGD wastewater is treated with softening and evaporation, producing two liquid streams: 1) evaporator distillate, which can be reused in the power plant, and 2) evaporator brine, which can be mixed with fly ash and transported offsite for disposal. The concept of this treatment mechanism is illustrated in Figure 8.

k k k k k k k



Process Flow Diagram
FGD Blowdown - ZLD with Softening Treatment
Indianapolis Power & Light Company (IPL) – Petersburg Generating Station

Q48. Please describe ZLD by reuse.

A48. A discharge can be eliminated if the wastewater is reused in the plant to supplement or replace a water source. This is more suitable for high-quality / low-salt wastewater (such as bottom ash transport water or some "Other Water" streams). Streams with higher salt content or abrasive material are not as good for reuse because they can cause equipment damage.

Q49. What other wastewater management options were evaluated for the runoff streams flowing to Petersburg Generating Station Outfall 007?

A49. Options evaluated for compliance strategy at Petersburg Generating Station Outfall 007 were to address the main wastewater flows to this outfall. These waste streams were 1) runoff from rainfall on the pile of waste solids from the Unit 3 scrubber mixed with fly ash, 2) wash water from washing truck tires that have worked around the area where the ash and scrubber solids are mixed, 3) runoff from rainfall on the Petersburg landfill that contains some contaminants from contacting the current landfill cover material, and 4) runoff from an outdoor storage pile of gypsum (the solid material produced in the Units 1, 2, and 4 FGD systems, which consists mostly of calcium sulfate).

The management options evaluated included: 1) source elimination (this would be a building over the Unit 3 scrubber solids and ash pile to eliminate pile runoff and associated wheel wash from trucks working around this pile; for the landfill, this would mean covering the current cover material with clay-type soil and/or a plastic membrane); 2) reuse the water as makeup water to the FGD system; 3) treat the water with FGD water; or 4) treat the water in a new treatment system and discharge it.

A. <u>HARDING STREET STATION</u>

Q50. What were results of the evaluation of relocating the discharge to the White River for the Harding Street Generating Station?

A50. Our evaluation showed that relocation would not result in effluent limit increases sufficient to reduce the cost of the required treatment systems. This is true with or without refueling of Unit 7. In particular, using the White River for discharging treated wastewater offers only a small increase to discharge limits for key pollutants (e.g., selenium) compared to the Lick Creek l imits. Hence treatment of selenium and other pollutants would still be required. Therefore, discharge relocation is not feasible for purposes of overall compliance, nor does it provide significant reduction of risk or overall cost of compliance.

Q51. What is the recommended compliance plan for Harding Street Generating Station if Unit 7 is not refueled?

A51. The recommended compliance plan includes:

Wastewater. The system includes:

a. A wastewater collection system of sumps, pumps, and pipes to transfer wastewaters from their point of generation to the treatment facilities including onsite Stormwater detention ponds.

b. FGD wastewater treatment in a "ZLD with recycle" system.

c. Treatment of bottom ash sluice water in existing ponds, enhanced by a chemical addition and aeration systems.

d. Seal trough water (which carries small amounts of bottom ash) would continue to flow to the Unit 7 waste sump, and from there, along with other Unit 7 waste sump; waters; be pumped to the Other Water treatment system.

e. Elimination of fly ash transport water by converting to dry fly ash handling.

f. Treatment of "Other Water" streams with tank -based physical/chemical treatment (mixed tanks and clarifiers).

g. Replacement of source water treatment's current demineralizer ion exchange beds and reverse osmosis (RO) system with a new reverse osmosis system with mixed -bed polishing and self-neutralization. This will reduce the risk of non -compliance due to residuals from the water treatment process.

Stormwater. The proposed compliance plan includes the following modifications:

a. Street sweeper purchase and use (such as to clean up fly ash off ground in loading area)
b. Reconnection or redesign of the Unit 7 bypass stack drain
c. Truck wheel wash
d. Unit 7 precipitator area dust control

e. Paving and drainage improvements
f. Canopy for outdoor dumpster storage area

The selected approach is described further in the CH2M HILL NPDES CSP, Section 8 (Attachment DHF-1).

Q52. Why was this compliance strategy recommended for Harding Street Generating Station if Unit 7 is not refueled?

A52. The recommended compliance strategy selected is considered the best choice because these changes represent a low risk of non-compliance at the lowest reasonable cost, and can be adapted to other potential future environmental regulations.

Q53. What did CH2M HILL recommend for the compliance alternative in which Harding Street Unit 7 is also converted to natural gas?

A53. If Harding Street is refueled to use natural gas rather than coal, the current internal wastewater streams related to ash and the FGD will be eliminated because a natural gas-fired unit would not produce ash that must be managed nor would it use a FGD system. There will still be some wastewater streams, such as cooling tower blowdown that will need to be treated. The recommended wastewater compliance approach if Unit 7 is refueled to natural gas includes:

Wastewater. The system includes:

a. A wastewater collection system of sumps, pumps, and pipes to transfer wastewaters from their point of generation to the treatment facilities including onsite Stormwater detention ponds.
b. Treatment of "Other Water" streams with tank-based physical/chemical treatment (mixed tanks and clarifiers).

Stormwater. The proposed compliance plan if Unit 7 is refueled to natural gas includes the following modifications:

a. Reconnection or redesign of the Unit 7 bypass stack drain

b. Paving and drainage improvements

c. Canopy for outdoor dumpster storage area

B. PETERSBURG GENERATING STATION

Q54. What were results of the evaluation of relocating the discharge to the White River for the Petersburg Generating Station?

A54. Our evaluation showed that relocation would not result in effluent limit increases sufficient to reduce the cost of the required treatment strategies. Even though a higher concentration of contaminants could be discharged, these contaminants would need to be treated and thus the overall costs of operation would not be reduced. There is uncertainty associated with relocation of discharge to the White River because the new effluent limits would not be known in a timely manner to ensure compliance. Additional risks associated with this option are discussed in the CH2M HILL NPDES CSP, Appen dix A (Attachment DHF-1).

Q55. What is the recommended compliance plan for Petersburg Generating Station?

A55. The technologies to be used include:

Wastewater. The system includes:

a. A wastewater collection system of sumps, pumps, and pipes to transfer wastewater from their point of generation to the treatment systems including onsite Stormwater detention ponds.

b. FGD wastewater treatment in a ZLD with recycle system.

c. Treatment of bottom ash sluice water in existing ponds, enhanced by chemical addition and aeration systems.

d. Elimination of fly ash transport water by no longer using wet sluicing of fly ash as a back-up to the existing dry fly ash handling system.

e. Treatment of "Other Water" streams with tank-based physical/chemical treatment (mixed tanks and clarifiers).

Compliance with permit limits for Outfall No. 007 will be accomplished using the following source control measures:

a. Gypsum pile – a building will be constructed to cover this pile and prevent rainfall from contacting the material. This BMP will also meet Stormwater non-numeric requirements of the NPDES permit.

b. Material pile with Unit 3 scrubber solids and ash – a building will be constructed to cover this pile and prevent rainfall from contacting the material. This BMP will also meet Stormwater non-numeric requirements of the NPDES permit.

c. Wheel wash stream – this will be discontinued since covering the Unit 3 scrubber solids and ash pile will help prevent the need for the wheel wash.

d. Landfill runoff – covering the current landfill cover material with material to prevent pollutants in the current landfill cover from entering Stormwater runoff.

These changes will also help ensure compliance with the NPDES permit's Stormwater requirements.

Stormwater. The proposed compliance plan in cludes the following modifications for the facility, in addition to the runoff -related changes described above (buildings over Unit 3 scrubber solids and ash pile and gypsum pile, landfill cover):

a. Improve dust suppression – river water supply fill station for water truck.

b. Street sweeper purchase and use (such as to clean up fly ash off the ground in loading area).

c. Add miscellaneous road paving and sediment control structures such as silt fencing, straw bales, or erosion control matting.

These technologies a re described further in the CH2M HILL NPDES CSP, Section 8 (Attachment DHF-1).

Q56. Why was this compliance plan recommended for Petersburg Generating Station?

A56. The recommended compliance strategy selected is considered the best choice because these changes represent a low risk of non-compliance at the lowest reasonable cost, and can be adapted to other potential future environmental regulations.

C. EAGLE VALLEY GENERATING STATION

Q57. What is the recommended compliance plan for the Eagle Valley Generating Station?

A57. As described in an earlier answer, the wastewaters regulated by the Eagle Valley station's permit that are generated by the power plant processes (such as ash transport water) will be eliminated by closing the station's coal-fired units. Therefore, the strategy for complying with the Eagle Valley NPDES permit is focused on the permit's Stormwater requirements. To ensure compliance with the NPDES Permit Conditions I.D and I.E, IPL has planned the following activities at the Eagle Valley Generating Station:

a. When fly ash is removed from ponds and placed in trucks for transport, minimize fugitive emissions and ash spills: clean the areas where ash may be loaded in trucks after each load or spill and do not load trucks when wind conditions are unfavorable.

b. Update inspection forms for consistency with the information required for the routine inspections and comprehensive inspections.

D. HARDING STREET AND PETERSBURG STATIONS

Q58. Please describe the potential impact of using the recommended NPDES CSP on the operation of IPL's generating units.

A58. The NPDES CSP will have limited impact on the operation of IPL generating stations. Impacts will include:

The concentration of chloride in the FGD liquid will increase; however, this should not impact operation. (This assumes that Harding Street Unit 7 is not refueled. If it is refueled to gas there will not be a FGD.)

The source water treatment system used at the Harding Street Generating Station will be modified, thus producing less wastewater to manage. (This assumes that Harding Street Unit 7 is not refueled. If it is refueled the change to source water treatment will not be needed for the compliance plan.)

At Petersburg and Harding Street Generating Stations, all fly ash will be managed with pneumatic systems (in which ash is moved by air) rather than wet sluiced. (This assumes that Harding Street Unit 7 is not refueled. If it is refueled to gas fly ash will not be generated.)

The wastewater treatment systems represent additional operation and maintenance responsibilities for the Harding Street and Petersburg Generating Stations above the responsibilities of the current wastewater systems (ash ponds). This is true regardless of whether Harding Street Unit 7 is refueled or not. If it is refueled to gas, the wastewater treatment system will be smaller and less costly than if Unit 7 is not refueled.

Q59. In summary, how will these proposed changes to wastewater management allow IPL to comply with the NPDES requirements?

A59. The elimination of wastewater from the FGD process and fly ash will significantly decrease the amount of regulated pollutants (such as mercury and selenium) in the stations' discharge. The treatment of other streams (such as cooling tower blowdown) and elimination of contamination source from others (such as covering the Petersburg gypsum pile) will also reduce the amount of regulated parameters in the discharges. IPL will follow the NPDES permits' monitoring requirements, which will help ensure that compliance is being maintained. This monitoring approach is described in the CH2M HILL NPDES CSP, Section 8.6.3 (Attachment DHF-1).

Q60. Please describe the impact of the selected NPDES compliance strategy on the management of CCR in the IPL generating fleet.

A60. Both the Harding Street and Petersburg Generating Stations currently send CCR material, including ash and FGD solids in FGD wastewater, to onsite surface impoundments or ponds. The NPDES project will not affect the current bottom ash management approach of wet sluicing bottom ash to onsite surface impoundments, from which most of the bottom ash is recovered. The NPDES compliance strategy will eliminate sending fly ash and FGD solids to the onsite surface impoundments. If Harding Street is refueled to natural gas CCR material will no longer be generated; however, the existing CCR impoundments and associated CCR wastewaters will need to be managed.

Q61. Please describe the impact of the selected NPDES compliance strategy on compliance with the anticipated effluent limitations guidelines in the IPL generating fleet.

A61. The NPDES compliance strategies selected for the Harding Street Station (with or without refueling) and Petersburg Generating Station appear to be adaptable with, and supportive of, compliance with the anticipated ELG. This understanding is based on the proposed ELG published in the Federal Register on June 7, 2013 in that:

The proposed ELG includes Best Available Technology ("BAT") limits on FGD water in some of the EPA's "preferred options" for existing sources. The BAT limits would require treating FGD water to low levels of mercury, selenium, arsenic, and nitrate/nitrite. The NPDES strategy includes treating each station's FGD wastewater by an evaporator system. The evaporator will produce an effluent (evaporator distillate) that has a high likelihood of complying with the ELG's BAT limits on FGD water, thereby allowing this water to be used elsewhere in the plant with minimal if any treatment. Further, if the distillate does not meet the BAT limits, the distillate can be routed to be reused within the FGD system, thereby making the FGD a ZLD system, which would result in the BAT limits not applying to the FGD water. Note that if Harding Street is refueled to natural gas it will not have a FGD wastewater stream.

The proposed ELG prohibits the discharge of fly ash transport water in all of the EPA's "preferred options" for existing sources. The proposed ELG prohibits the discharge of bottom ash transport water in some of the EPA's "preferred options" for existing sources. If both Petersburg and Harding Street Stations continued to operate on coal, the NPDES compliance plan would result in no discharge of fly ash transport water from the IPL plants. Note that if Harding Street is refueled to natural gas as proposed, it will not generate a fly ash or bottom ash transport wastewater stream.

Q62. Did you provide estimated costs to IPL for wastewater management to achieve NPDES compliance?

A62. Yes. CH2M HILL provided capital, annual operating, and net present value cost estimates.

Q63. Is CH2M HILL the Engineering Procurement and Construction ("EPC") contractor for the IPL NPDES compliance project?

A63. No. CH2M HILL is serving as the Owner's Engineer ("OE") for the IPL NPDES compliance project. In this role, CH2M HILL has reviewed the EPC contractor bids.

Q64. How were cost estimates developed during the evaluation of compliance options?

A64. CH2M HILL developed costs based on values from a number of sources and site-specific factors. Costs were developed primarily using treatment equipment vendor quotations along with CH2M HILL cost estimating tools and experience on other similar projects. Vendor quotations were either specific to this project (such as the ZLD evaporator system) or based on cost curves of flow versus cost developed from vendor quotations. While these cost estimates are based on consideration of a number of site-specific factors, they are approximate. The project team screened technologies through a multi-stage process, with more precise cost estimates prepared in later stages as the compliance options were narrowed down. More detail on the selection process is provided in the CH2M HILL NPDES CSP, Appendices B and C (Attachment DHF-1).

The cost estimates were prepared to assist in comparing alternate treatment systems, and are based on information available at the time the estimates were prepared. The cost estimate for the options that were screened out in the first screening stage were developed using the methodology for a Class 5 estimate as defined by the Association for the Advancement of Cost Engineering International ("AACEI") 2011 guidance. Typically, the accuracy range for a Class 5 estimate for the process industries is +100 percent/ -50 percent. CH2M HILL developed the cost estimates for those options passing through the first screening stage using the methodology for a Class 4 estimate as defined by

AACEI, including equ ipment factored or parametric models. Typically, the accuracy range for a Class 4 estimate for the process industries is +50 percent/ -30 percent. The final costs of the project and resulting feasibility will depend on actual labor and material costs, co mpetitive market conditions, actual site conditions, final project scope, implementation schedule, continuity of personnel and engineering, and other variable factors. CH2M HILL's cost estimates for the selected compliance strategy are in Section 6.3 (Harding Street with refueling) and Section 8 (Harding Street without refueling, and Petersburg) of the CH2M HILL NPDES CSP.

Q65. What was included in the cost estimates developed during the alternatives evaluation?

A65. Capital costs included equipment, installation, materials, and labor, construction costs, indirect costs, and startup/commissioning costs. Capital costs presented in the CH2M HILL NPDES CSP do not include: modifying roads to treatment system, escalation if built for compliance later than 2017, initial set of shelf spares and spare parts, pond closure/post-closure costs (separate project) for areas outside the footprint of the Petersburg wastewater treatment system, fly ash conversion at Petersburg Generating Station (separate project), ash landfill con struction, Owner's Costs ("OC"), construction management, or allowance for funds used during construction ("AFUDC"). Operations and maintenance ("O&M") costs include operating labor, maintenance labor, maintenance materials, treatment chemicals, waste disposal, and power consumption. 10-year net present value ("NPV") costs were also provided. The NPV costs combine capital and O&M costs into a single value that represents the amount of money that one could put up at the beginning of the project to fund construction and operation of the facility through the first ten years of its assumed useful life.

Q66. What were the cost estimates developed during the alternatives evaluation for the recommended strategies?

A66. As listed in the CH2M HILL NPDES CSP (Attachment DHF-1), the cost estimate, inclusive of those items described above, were as shown in the table below. Estimating contingency is used as a standard element within cost estimates at this early phase of a project design. The CSP includes the estimate presented both with (Table ES-1) and without (Tables 8-2 and 8-3) the contingency. For purposes of this testimony, the contingency is included in costs.

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T	T T TM T ff dY e	dY e	T b T dY e	oni T dY e
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T Td T e	Mf bg	Ml gbd	Mdbk	Ml l bd
	Mekh	Mel l	Medbf	Ml hi
T		Mdbdg	Mdbddg	Mdbdh

Uay G G G G G G G GWd cagd
UUa G G G G G G G G' yG Gb G G G YG G G G G' yG
oGG a G G G G YG G G GG G
YG G YG G G G YG G G G G GxG GyY
G G G G G YG G G G G G G b

Q67. Did CH2M HILL review the EPC bids for this work?

A67. Yes.

Q68. Does CH2M HILL consider the EPC bid to be reasonable?

A68. CH2M HILL believes that the winning EPC bid is reasonable. The EPC bid is higher than CH2M HILL estimates of the EPC scope, but the bid is well within the +50/-30 percent accuracy range of our e stimates. It is typical for cost estimates to differ as projects are more thoroughly defined, as was the case from when CH2M HILL conducted the Class 4 estimate of the Compliance Strategy Plan to when the EPC firm bid the project.

Q69. What estimates were d eveloped for Petersburg Station with one or more of its four units being closed or converted to natural gas?

A69. CH2M HILL evaluated for IPL how the treatment system needed for NPDES compliance would change if any one of the coal -fired units at the Petersburg Station were to be either closed or converted to natural gas, or if both Units 1 and 2 were to be closed. This resulted in nine scenarios. Four of the scenarios are for closing any one of the units individually, one scenario is for closing both Units 1 a nd 2, and four scenarios are for converting any one of the units to gas. Estimates of the cost savings from unit closure or conversion were prepared. These are summarized in the table below. The cost savings resulting from unit closure or conversion differ by unit primarily because of required capacity differences for the ZLD system resulting from the way water can or cannot be reused in each unit's FGD system. Eliminating Unit 2 would actually increase cost, as it would affect the FGD recycle scheme leading to an increase in size of the wastewater treatment evaporator system. This savings are shown in the table below, and explained more fully in Attachment DHF-2.

T T T T hT y	T T dY ef
w G G G	x y
G G G Ge	n
G G G Gf	æ
G G G Gg	ee

G G G Gh	n
G GeG Gf	en
Uay G G G G G G G G GWagd b x G G G G G G G YG G G b	

The cost savings were a relatively small percent of the total costs beca use the wastewater system is a plant-wide system (i.e., one treatment system for all FGD wastewater), rather a system for each unit (as would be the case in a project such as installing a bag house on each unit to meet air emission regulations).

Q70. Are the compliance projects recommended by CH2M HILL necessary for IPL to comply with the NPDES requirements imposed by EPA under the Clean Water Act?

A70. Yes.

Q71. Will the public convenience and necessity be served by the proposed environmental compliance?

A71. Yes.

Q72. Does this conclude your prefiled direct testimony?

A72. Yes.

VERIFICATION

I Dennis H. Fink, Senior Project Manager for CH2M HILL, affirm under penalties for perjury that the foregoing representations are true to the best of my knowledge, information, and belief.

Dennis Fink

Dennis H. Fink

Dated: October 15, 2014

Draft

NPDES Compliance Strategy Plan

Prepared for

Indianapolis Power & Light Company (IPL)

October 2014

CH2MHILL®

Contents

Appendices

Tables

Figures

Acronyms and Abbreviations

AACEI	Association for the Advancement of Cost Engineering International
ACI	activated carbon injection
AO	Agreed Order
BA	bottom ash
BAT	best available technology
BMP	best management practice
BPJ	best professional judgment
BPT	best practicable technology
CCR	Coal Combustion Residuals
CFR	Code of Federal Regulations
CSP	Compliance Strategy Plan
CWA	Clean Water Act
DMR	discharge monitoring report
SI	sorbent injection
ELG	Effluent Limitation Guidelines
EPA	U.S. Environmental Protection Agency
EPC	engineering, procurement and construction
ERM	Environmental Resources Management
FA	fly ash
FBR	fluidized bed reactor
FGD	Flue Gas Desulfurization
FGMC	flue gas mercury control
gpm	gallons per minute
HAPs	hazardous air pollutants
IDEM	Indiana Department of Environmental Management
IPL	Indianapolis Power & Light Company
IUCS	Illinois University Conversion System
IURC	Indiana Utility Regulation Commission
M&R	monitor and report
MATS	Mercury and Air Toxics Standards
MBBR	moving bed bioreactor
NCMC	Non-chemical metal cleaning
NPDES	National Pollutant Discharge Elimination System
O&G	oil and grease
O&M	operations and maintenance
PSD	Prevention of Significant Deterioration
SIC	Standard Industrial Classification
SPCC	Spill Prevention, Control, and Countermeasures
SWPPP	Storm Water Pollution Prevention Plan
TBEL	Technology-Based Effluent Limit
TRC	total residual chlorine
TSS	total dissolved solids

ATTACHMENT DHF-1
CAUSE NO. 44540

USGS	U.S. Geological Survey
WQBEL	water quality based effluent limit
ZLD	zero liquid discharge
ZVI	zero valent iron

Executive Summary

On August 28, 2012, the Indiana Department of Environmental Management (IDEM) issued National Pollutant Discharge Elimination System (NPDES) permits to the IPL Petersburg, Harding Street, and Eagle Valley Generating Stations. NPDES permits regulate and authorize specific industrial wastewater and stormwater discharges to the waters of the United States under Section 402 of the Federal Water Pollution Control Act (also referred to as the Clean Water Act or "CWA"). The IPL NPDES permits became effective on October 1, 2012. These permits contain technology based effluent limits (TBELs) and new water quality based effluent limits (WQBELs) for both Harding Street and Petersburg Generating Stations and non-numeric stormwater effluent limits for all three IPL Generating Stations. The compliance date for the new non-numeric stormwater and total residual chlorine (TRC) (Petersburg only) effluent limits is October 1, 2013. Per Agreed Orders, issued on April 29, 2013, the new metal WQBELs compliance date for the Petersburg and Harding Street Generating Stations is September 29, 2017. Given the potential significant cost implications for compliance with the final NPDES permits, an assessment of the technologies, costs, and risks was developed in order for IPL to comply with this regulation in the specified timeframe.

This Compliance Strategy Plan (CSP) is a comprehensive plan to ensure future compliance with NPDES permit limits as set forth in Section 402 of the Clean Water Act (CWA), for the IPL Harding Street, Petersburg, and Eagle Valley Generating Stations. The CSP considers potential costs and risks associated with NPDES compliance, pending regulations, and operational changes. The potential risks include, but are not limited to, uncertainty of technologies being considered (unproven technology), future federal and state regulations and limits, uncertainty of wastewater impacts due to MATS, existing operational deficiencies (e.g. ash pond stability issues, pond retention time), and limited data for some of the wastewater streams at each site.

The primary objectives of this CSP are to:

- Determine a preferred wastewater and stormwater compliance strategy plan with low risk of non-compliance and adaptability to other potential future environmental regulations at the lowest reasonable cost, including detailed plans for wastewater management, reuse, and treatment;
- Recommend a compliance monitoring strategy; and
- Recommend a schedule for the wastewater and stormwater compliance strategy plan components (i.e., the treatment systems), taking into account upcoming additional wastewater management requirements of pending regulation.

Recommended Compliance Strategy Plan

The current wastewater management approach at Petersburg and Harding Street Generating Stations is the co-treatment of process wastewaters in ponds. The wastewater compliance team evaluated the most effective method to treat the wastewaters including continued co-treatment of combined process wastewaters and the segregation of wastewater streams. For both the Harding Street and Petersburg Generating Stations, the recommended compliance strategy includes segregation of the process wastewaters into three wastewater groups for treatment: Flue Gas Desulfurization (FGD) wastewater, ash transport water, and other wastewaters. The Other wastewater group includes, but is not limited to, cooling tower blowdown, coal pile run-off, non-chemical metal cleaning wastewater, and various low-volume wastewaters. The wastewater compliance team reviewed several different treatment technologies, considered outfall relocation to the White River, and evaluated water recycling. The recommended compliance strategy is shown in **Table ES-1**. Ancillary compliance strategy elements include: segregating wastewater within the power block to allow the three-group approach, modifying Harding Street's source water treatment to reduce waste from regenerating the water treatment ion exchange system (regenerant waste), eliminating sources of runoff contacting process areas at Petersburg, Petersburg ash pond stability remediation, and (at all three stations) modifying stormwater management practices to meet permit requirements.

TABLE ES-1
Recommended NPDES Compliance Strategy Plan Summary

<table>
<tr><th rowspan="2">Station</th><th rowspan="2">Units</th><th rowspan="2">FGD Water</th><th rowspan="2">Fly Ash Water</th><th rowspan="2">Bottom Ash Water</th><th rowspan="2">Other Water[1]</th><th rowspan="2">Stormwater</th><th colspan="3">Cost Without Contingency – see Tables 8-2 and 8-3 for Estimated Cost with Estimating Contingency</th></tr>
<tr><th>Capital Costs[2] ($MM)</th><th>First Year O&M Costs[2] ($MM)</th><th>10-yr NPV[2] ($MM)</th></tr>
<tr><td>Harding Street if Units 5, 6, and 7 Gas-Fired</td><td></td><td colspan="3">Convert to natural gas prior to 2017. These streams will then no longer exist. [3]</td><td>Treat with tank-based physical/chemical treatment and discharge.</td><td>Stormwater management changes</td><td>$20</td><td>$0.6</td><td>$24</td></tr>
<tr><td rowspan="3">Harding Street if Unit 7 Coal-Fired</td><td>3,4</td><td colspan="4">Retired as assets in 2013</td><td rowspan="3">Stormwater management changes</td><td rowspan="3">$125</td><td rowspan="3">$5.3</td><td rowspan="3">$160</td></tr>
<tr><td>5,6</td><td colspan="3">Convert to natural gas prior to 2017. These streams will then no longer exist.</td><td>If converted to gas, can manage non-CCR wastewaters through tank-based physical/chemical and/or direct discharge of cooling water</td></tr>
<tr><td>7</td><td rowspan="2">ZLD with Recycle - Settle out solids and recycle portion to FGD. Remaining water treat by softening + evaporation, reuse distillate, off-site disposal of brine with fly ash.</td><td rowspan="2">Convert to full dry handling (no back-up wet sluicing)</td><td rowspan="2">Continue to treat in ponds, add a chemical and aeration system, address ash pond stability deficiencies (Petersburg only)</td><td>Treat with tank-based physical/chemical treatment and discharge.
And: U7 waste sump - compliance by water treatment upgrade to reduce amount of regeneration waste to sump</td></tr>
<tr><td>Petersburg</td><td>1-4</td><td>Treat with tank-based physical/chemical treatment and discharge Runoff to Outfall 007: source elimination[4]</td><td>Stormwater management changes</td><td>$158</td><td>$10.2</td><td>$225</td></tr>
<tr><td>Eagle Valley</td><td></td><td colspan="4">Retire units prior to 2017</td><td>Stormwater management changes</td><td>$0.03</td><td>$0.003</td><td>$0.04</td></tr>
</table>

[1] Compliance plan is for bottom ash tank overflow wastewater to flow to Other Water group. S ee Appendices B and C for more detail on this.
[2] Note that these costs are considered Class 4 estimates. Note that most, but not all, of the Capital cost will be in one Engi neer Procure Construct (EPC) contract per plant. Some costs (such as dry fly ash handling, stormwater management, Harding Street water treatment upgrade affecting Unit 7 sump, Petersburg ash pond remediation , chemical feed/aeration systems, etc.) will be done under separate contracts. Capital costs include equipment, installation, materials, and labor, construction costs, indirect costs, and startup/ commissioning costs. Capital costs do not include: modifying roads to treatment system, escalation if built for compliance later than 2017, initial set of shelf spares and spare parts, pond closure/post-closure costs (separate project), ash landfill construction, Owner's Costs (costs to IPL for its employees' work related to project), construction management, or allowance for funds used during construction (AFUDC). See also Section 8 for more description of cost estimates.
Operations and maintenance (O&M) costs include operating labor, maintenance labor, maintenance materials, treatment chemicals, waste disposal, and power consumption.

TABLE ES-1
Recommended NPDES Compliance Strategy Plan Summary

[3] The HSS natural gas NPDES compliance strategy was based on the assumption that legacy ash pond wastewater would be discharged prior to September 30, 2017 and therefore, additional treatment would not be necessary. If it is determined that legacy ash pond wastewater cannot be discharged completely prior t o the aforementioned date, treatment will need to be evaluated as part of the ash pond system closure process.

[4] Source elimination includes a building over the IUCS (Illinois University Conversion System) pile, a building over the outdoor gypsum pile, and an evaluation of whether covering the current landfill poz-o-tec cover with a new cover layer will be required.

SECTION 1

Introduction

1.1 Introduction

Indianapolis Power & Light Company (IPL) operates coal-fired steam electric power plants at the Harding Street, Petersburg, and Eagle Valley Generating Stations. Wastewater and stormwater discharges from these facilities are regulated by Section 402 of the Federal Water Pollution Control Act (a.k.a. the Clean Water Act or "CWA"), the Indiana Environment Code, and implementing regulations as found in Indiana Administrative Code (IAC) Title 327 (Water Pollution Control Division). IPL must comply with effluent limitations, monitoring requirements, and all other provisions of National Pollutant Discharge Elimination System (NPDES) Permit Nos. IN0004685, IN0002887, and IN0004693 issued to the Harding Street, the Petersburg, and the Eagle Valley Generating Stations, respectively.

This Compliance Strategy Plan (CSP) is a comprehensive plan to ensure compliance with National Pollutant Discharge Elimination System (NPDES) permit limits, excluding thermal discharge limitations contained in NPDES Permit Condition III, as set forth in Section 402 of the CWA, for the IPL Harding Street, Petersburg, and Eagle Valley Generating Stations. This CSP considers potential costs and risks associated with compliance, pending regulations, and operational changes.

Renewed NPDES permits were issued for the IPL Generation facilities in August 2012, with an effective date of October 1, 2012. These permits contain numeric limits for several pollutants in the facilities wastewater and non-numeric limits for stormwater discharges, and report-only requirements on other parameters. The discharge limits require changes to wastewater and stormwater management practices at each generating station in order to achieve compliance with the NPDES permits. The new discharge limits of concern described in this CSP are primarily trace contaminants in ash pond outfalls (Outfall No. 001 at the Petersburg Station and Outfall No. 006 at the Harding Street Station) and stormwater runoff contacting Coal Combustion Residuals (Petersburg Outfall No. 007). These outfalls at the Harding Street and Petersburg stations all discharge to small water bodies (Lick Creek). Both Harding Street and Petersburg NPDES permits initially required compliance with new stringent water quality-based effluent limitations (WQBEL) by October 1, 2015; however, the Indiana Department of Environmental Management (IDEM) issued Agreed Orders on April 29, 2013, which extended the compliance date for WQBELs to September 29, 2017. The effective date of the non-numeric stormwater limits for all IPL generation stations was October 1, 2013 with an annual requirement to review both structural and non-structural controls to ensure compliance with such discharge limits.

The considerations and potential risks include, but are not limited to, uncertainty of technologies being considered (unproven technology), future federal and state regulations and limits, uncertainty of wastewater impacts due to MATS, existing operational deficiencies (e.g. ash pond stability issues, pond retention time), and limited data for some of the wastewater streams at each site.

The current wastewater management approach at both generating stations is the co-treatment of process wastewaters in ponds. The wastewater compliance team evaluated the most effective method to treat the wastewaters including continued co-treatment of combined process wastewater and the segregation of wastewater streams. For both the Harding Street and Petersburg Generating Stations the recommended compliance strategy plan is segregation of the process wastewaters into three wastewater groups including FGD wastewater, ash transport water, and other wastewaters. The Other wastewater group includes, but is not limited to, cooling tower blowdown, coal pile run-off, non-chemical metal cleaning wastewater, and various low-volume wastewaters. The wastewater compliance team reviewed several different treatment technologies, considered outfall relocation to the White River, and evaluated water recycling. Ancillary compliance strategy elements include segregating wastewater within the power block to allow the three-group approach, modifying Harding Street water treatment to reduce regenerant waste, and modifying stormwater management practices to meet permit requirements. It should be noted that this compliance plan assumes Harding Street Unit 7 continues to be coal-fired. An alternative compliance strategy plan is presented in Section 6.3 if Harding Street is converted to gas-fired.

1.2 What is Gained from Implementing a Wastewater Treatment Strategy

In performing cost-benefit analysis based on compliance with treatment limits established by IDEM, the treatment benefit considered is the removal of pollutants from the receiving water body. The permit limits were set by IDEM based on water quality monitoring data collected during IPL's last permit cycle, which showed the discharge to be above water quality-based effluent limits for pollutants of concern. The current permit lists several parameters with "report only" requirements now, which could lead to future limits. In all treatment options considered, the pollutants would be removed from IPL's wastewater and disposed of as a solid waste. The large majority of pollutant mass removed is selenium. The overall benefit approximated[1] by comparing current pollutant discharge with the new discharge limits is 500 pounds of pollutants per year at Harding Street and 3,100 pounds of pollutants per year at Petersburg.

Other positive outcomes as a result of implementation of an effective wastewater treatment strategy include:

- The facilities may continue to operate. (Compliance with NPDES permits is necessary for Harding Street, Eagle Valley, and Petersburg to continue to operate.)
- IDEM's new antidegradation standard prohibits additional lowering of water quality if a waterbody is impaired. The White River at both the Harding Street and Petersburg Generating Stations is impaired for mercury in fish tissue. Because the MATS project will remove mercury from air emissions and capture that mercury as part of the fly ash, it is possible that IDEM could prohibit the increased loading of mercury to the White River associated with fly ash generated after the MATS controls are operational.
- Anticipation of future needs can economically mitigate future costs.

1.3 Project Objectives

The objectives of this CSP are to:

- Determine a preferred wastewater and stormwater compliance strategy plan with low risk of non-compliance and adaptability to other potential future environmental regulations at the lowest reasonable cost, including detailed plans for wastewater management, reuse, and treatment;
- Recommend a compliance monitoring strategy; and
- Recommend general timing associated with control installations, taking into account upcoming additional wastewater management requirements of pending regulations.

1.4 Project Scope

The scope of work leading to this CSP included the following steps:

1. Reviewing existing wastewater compliance information, and identifying and filling any wastewater data gaps associated with compliance with NPDES permit limits.
2. Evaluating existing wastewater management practices and identifying pollutants that would not be in compliance with NPDES current and future permit limits.
3. Completing a screening evaluation of feasible and cost-effective wastewater management and treatment options to achieve compliance with NPDES permit limits.
4. Evaluating risks beyond the current NPDES permit, including but not limited to proposed regulations.
5. Selecting the preferred compliance strategy, including wastewater management changes to be implemented along with associated cost and timing, compliance monitoring, and permit modification applications (if needed).

[1] This is an approximation because current discharge varies and because actual discharge would be lower than limit to provide a safety factor for compliance.

6. Incorporating the stormwater compliance strategy as recommended by Environmental Resources Management (ERM) in final reports issued in December 2012 and February 2013. The stormwater compliance strategy recommendations being implemented are summarized in Sections 2.1.2 and 2.2.2 of this CSP.

1.5 Project Team Design

The wastewater compliance team includes representatives from different functional areas across the company, including IPL Environmental Policy, plant (Petersburg and Harding Street) leadership, Engineering, plant Environmental, Fuel Supply, Legal, and Regulatory Affairs. A wastewater engineering and compliance consulting firm, CH2M HILL Engineers Inc. (CH2M HILL), also provided technical expertise throughout the process by participating in meetings, providing ongoing support, and developing this CSP containing compliance options with associated costs, identification of regulatory compliance risks, and recommendation of a compliance strategy.

1.6 Document Organization

The remainder of this document is organized into the following sections:

- Project background including effluent limits in the current permit is included in **Section 2**.
- A description of the two stations including their current conditions, existing effluent control technologies, and IPL's plans for future operation is included in **Section 3**.
- **Section 4** reviews wastewater management alternatives.
- **Section 5** reviews compliance strategy risks, such as potential future regulations.
- **Section 6 (Harding Street)** and **Section 7 (Petersburg)** present a review of the compliance options available at each of the two plants.
- **Section 8** summarizes the recommended compliance strategies.

Supporting information is provided in appendices. The appendices contain memorandums that provide supporting information on Petersburg discharge relocation (**Appendix A**), the basis of design and the alternatives evaluation (**Appendices B and C**), the Petersburg Outfall No. 007 basis of design and alternatives evaluation (**Appendix D**), and the evaluation of bottom ash water options **(Appendix E)**.

SECTION 2

Project Background – Existing Discharge Permits

This section summarizes the requirements of the NPDES permits issued to IPL's coal-fired stations. The Petersburg and Harding Street permits contain new interim and final WQBELs limits, and contain TBELs (such as iron) with compliance dates in 2012 and 2013. The NPDES permits require compliance with the new final WQBELs limits for the regulated facility NPDES Outfalls no later than October 1, 2015, which was extended to September 29, 2017 in the AOs for Case No. 2013-21497-W and Case No. 2013-21498-W. Interim limits apply until the final limits become effective. The effective date of the non-numeric stormwater limits was October 1, 2013 for all IPL generation stations, with an annual requirement to review both structural and non-structural controls to ensure compliance with such discharge limits. NPDES permits regulate/authorize specific industrial wastewater and stormwater discharges to the waters of the United States under Section 402 of the CWA.

2.1 Existing Effluent Limits - Harding Street Generating Station

NPDES Permit No. IN0004685 issued to the Harding Street Generating Station on August 28, 2012, corrected on September 28, 2012, and modified on May 8, 2013, contains new WQBELs and monitoring requirements for ash pond effluent (Outfall No. 006). The permit also has monitoring requirements for a Flue Gas Desulfurization (FGD) water internal monitoring point (Outfall No. 101), which is expected to be subject to new requirements based on the pending Steam Electric Generating Station ELG Rule. Non-numeric stormwater limits are included for the first time in the permit.

2.1.1 Outfall Discharge Limitations (NPDES Permit Condition I.A)

NPDES Permit No. IN0004685 contains new limits and/or monitoring requirements for the regulated outfalls identified in **Table 2-1**. The applicable limits and monitor and report (M&R) requirements for Outfall No. 006 and Outfall No. 101 are presented in **Table 2-2.** The effluent limits and M&R requirements for Outfall Nos. 001, 002, and 005 are shown in **Table 2-3**. The M&R data provided to IDEM and the U.S. Environmental Protection Agency (EPA) will be used to determine if new WQBELs are required; therefore, there is a moderate risk that these pollutants will have WQBELs in the next issuance of the permit. Some of the pollutant limits that apply to Outfall No. 006 have an *Interim* or *Final* designation. Interim limits apply upon the effective date of the permit (October 1, 2012), while the final permit limits come into effect after an established compliance period.

TABLE 2-1
Regulated Wastewater Streams at the Harding Street Generating Station

Outfall Number	Regulated Wastewater Stream	Receiving Water Body
001, 002	Non-Contact Cooling Water	West Fork of the White River
005	Non-Contact Cooling Water, Stormwater Runoff, and Intake Screen Backwash	Confluence of Lick Creek and the West Fork of the White River
006	Ash Pond[1]	Lick Creek, a tributary to the West Fork of the White River
101 (Internal)	FGD Discharge	Ash Pond
SW-1, SW-4, SW-7, SW-8, SW-12, SW-14[2]	Stormwater	Highland Creek (Ditch), Lick Creek, West Fork of the White River

[1] The ash pond (Outfall No. 006) includes wastewater from the Unit 7 recirculating cooling tower blowdown ; demineralizer wastes; condensate polisher waste; ash and pyrite system; boiler blowdown; boiler, condenser, air pre-heater and cooling cleaning wastes; FGD system blowdown; miscellaneous FGD wastewaters; floor and yard drains; stormwater; ash pyrite system; water treatment wastes; and non-chemical metal cleaning wastes.

[2] Discharges from the identified Outfall Numbers are considered representative of discharges from all stormwater outfalls at th e Harding Street Generating Station.

TABLE 2-2
Harding Street Generating Station NPDES Permit Limits for Outfall No. 006 (Ash Pond Discharge) and Monitor & Report Requirements of Outfall No. 101 (FGD Discharge)[1]

		006 (Ash Pond)[1]		
Parameter	**Units**	**Effective Date [3]**	**Monthly Average**	**Daily Maximum**
TSS[4]	mg/L	Oct. 2012	30	99
O&G[4]	mg/L	Oct. 2012	15	20
Mercury[2]	ng/L	Final (Sep. 2017)	12	20
Selenium[2]	mg/L	Final (Sep. 2017)	0.029	0.058
Cadmium[2]	mg/L	Final (Sep. 2017)	0.0022	0.0045
Copper[2]	mg/L	Interim (Oct. 2012)	0.03	0.06
	mg/L	Final (Sep. 2017)	0.025	0.05
Chromium[2]	mg/L	Jun. 2013	0.2	0.2
Zinc[2]	mg/L	Jun. 2013	0.22	0.45
Iron[2, 4]	mg/L	Oct. 2012	1.0	1.0
pH[4]	s.u.	Oct. 2012	--	6.0 to 9.0
Total Residual Chlorine	mg/L	Oct. 2012	0.01	0.02

Notes:

[1] Outfall No. 006 has report-only requirements for aluminum, ammonia as nitrogen (N), arsenic, boron, cadmium (interim), chlorides, flow, lead, manganese, mercury (interim), nickel, phosphorus, selenium (interim), sulfate, and total dissolved solids (TDS).

Outfall No. 101 (FGD), not shown, has report-only requirements for ammonia as N, arsenic, boron, biochemical oxygen demand (BOD), cadmium, chlorides, chromium, copper, flow, iron, lead, manganese, mercury, O&G, pH, phosphorus, selenium, TDS, total suspended solids (TSS), and zinc. The report-only requirements take effect on the date of permit issuance.

[2] The identified metals are as total recoverable.

[3] The NPDES Permit requires compliance with the final permit limits no later than October 1, 2015, which was extended to September 29, 2017, in the Agreed Order for Case No. 2013-21498-W. Interim limits apply until the final limits become effective. The NPDES Permit was modified on May 8, 2013, to include limits for chromium and zinc that became effective on June 1, 2013.

[4] TBEL. Other limits presented in the table are WQBELs.

ng/L = nanograms per liter

TABLE 2-3
Harding Street Generating Station NPDES Permit Limits for Outfall Nos. 001, 002, and 005 (Non-Contact Cooling Water, Stormwater Runoff, and Intake Screen Backwash)

		001, 002, 005 (Non-Contact Cooling Water)		
Parameter	**Units**	**Comments**	**Monthly Average**	**Daily Maximum**
Flow	MGD	Effluent, Upstream	Report	Report
Temperature[2]	°F	Intake, Effluent, Downstream	Report	Report
TRC	mg/L	Continuous	0.01	0.02
		Intermittent	--	0.2
Total Residual Oxidants	mg/L	Continuous	--	< 0.06
		Intermittent	--	0.2
Copper[1]	mg/L		Report	Report
Iron[1]	mg/L		Report	Report
Mercury[1]	ng/L		Report	Report
TSS	mg/L		Report	Report
Oil & Grease	mg/L		Report	Report
pH	s.u.	Min/Max		6.0 to 9.0

TABLE 2-2
Harding Street Generating Station NPDES Permit Limits for Outfall No. 006 (Ash Pond Discharge) and Monitor & Report Requirements of Outfall No. 101 (FGD Discharge)[1]

		006 (Ash Pond)[1]		
Parameter	**Units**	**Effective Date [3]**	**Monthly Average**	**Daily Maximum**

[1] The identified metals are as total recoverable.
[2] Thermal limits are in Part III of the permit.

2.1.2 Stormwater Requirements (NPDES Permit Conditions I.D and I.E)

NPDES Permit Condition I.D contains new stormwater non-numeric effluent limits. Per this permit condition, IPL was required to perform evaluations of existing stormwater structural and non-structural control measures (including best management practices [BMPs]) to ensure appropriate controls are in place to minimize exposure, to the extent achievable that are technologically available and economically practicable and achievable, in light of best industry practice. IPL was also required to identify areas where existing control measures do not minimize exposure based on the definition provided in NPDES Permit Condition I.D and modify or replace with the appropriate control measures to ensure compliance with the limits contained in the aforementioned permit condition. These requirements became effective on October 1, 2013 (within 12 months of the permit effective date), and are subject to annual review thereafter.

IPL is required to select, design, install, and implement control measures (including BMPs) to meet the non-numeric stormwater effluent limits. The non-numeric effluent limits are 24 requirements that include minimization of exposure, housekeeping, operation and maintenance (O&M), spill prevention and response, management of runoff, and training. Control measures used to comply with these requirements are those that are technologically available and economically practical and achievable in light of best industry practice. In addition, seven design considerations are part of the control method selection and include means of achieving the requirements efficiently and in the interest of water quality goals.

NPDES Permit Condition I.E contains requirements for IPL to revise and update the Stormwater Pollution Prevention Plan (SWPPP) according to the required contents specified in this section. The SWPPP is required to be revised within 12 months of the permit effective date, by October 1, 2013.

In February 2013, Environmental Resources Management (ERM) issued a stormwater Review Findings Report that assessed structural and non-structural controls and addressed compliance gaps associated with NPDES Permit Conditions I.D and I.E (ERM, 2013). To ensure compliance with this permit condition, IPL plans to make the following modifications for the Harding Street facility. It should be noted that the years shown are tentative and subject to change:

1. Street Sweeper purchase and use (such as to clean up fly ash off ground in loading areas). This activity is planned for 2014. [Will not be needed if Harding Street is converted to natural gas fired]
2. Reconnection or redesign of the Unit 7 Bypass stack drain. This activity is planned for 2014.
3. Truck wheel wash. This activity is planned for 2014. [Will not be needed if Harding Street is converted to natural gas fired]
4. Unit 7 Precipitator Area Dust Control. This activity is planned for 2014. [Will not be needed if Harding Street is converted to natural gas fired]
5. Plant Paving and Drainage Improvements. This activity is planned for 2014-2015.
6. Canopy for outdoor dumpster storage area. This activity is planned for 2014.
7. Update inspection forms. Make them consistent with the information required for the routine inspections and comprehensive inspections. This activity was completed in 2012-2013.
8. Clarify with IDEM the intent of Permit Condition No. I.D.4.j. This activity was completed in 2013.

9. Revise and update the SWPPP. This activity was completed in 2013.

2.2 Existing Effluent Limits - Petersburg Generating Station

NPDES Permit No. IN0002887 issued to the IPL Petersburg Generating Station on August 28, 2012, corrected on September 28, 2012, modified on May 8, 2013 and October 31, 2013, and corrected on November 8, 2013, contains the new WQBELs for ash pond effluent (Outfall No. 001) and FGD Sludge Disposal Site Runoff (Outfall No. 007). The permit also has monitoring requirements for the FGD discharges (Outfall Nos. 111 and 112), which are expected to be subject to new requirements based on the pending Steam Electric Generating Station ELG Rule. Discharge limits are also included for cooling tower blowdown and non-contact cooling water. Stormwater limits, which include for the first time non-numeric effluent limitations, are also included in the permit.

2.2.1 Outfall Discharge Limitations (NPDES Permit Condition I.A)

NPDES Permit No. IN0002887 contains new limits and monitoring requirements for the regulated outfalls identified in **Table 2-4**. The effluent limits and requirements for Outfall Nos. 001, 007, 111, and 112 are shown in **Table 2-5**. The M&R data provided to IDEM and EPA will be used to determine if new WQBELs are required; therefore, there is a moderate risk that these pollutants will have WQBELs in the next issuance of the permit. Similar to the Harding Street facility, the interim limits apply upon the effective date of the permit and the final limits are subject to the same compliance deadline of September 29, 2017.

TABLE 2-4
Regulated Wastewater Streams at the Petersburg Generating Station

Outfall Number	Regulated Wastewater Stream	Receiving Waterbody
001	Ash Pond[1]	Lick Creek
002	Once Through Non-Contact Cooling Water, Plant Quench Water, Boiler Blowdown, Soot Blower Drains, Makeup Water Intake Screen Strainer Backwash, and Stormwater Outfalls 003S, 025S, and 026S	White River
005, 006, 008	Cooling Tower Blowdown	Lick Creek
007	Unit 3 FGD Dewatering Wastewater, CCR Landfill Runoff (001S), and Stormwater Discharge from 004S	Lick Creek
101 (Internal)	Sanitary WWTP	Ash Pond
201 (Internal)	Low Volume Wastewater: Units 1 and 2 Boiler Blowdown	Discharge Canal
111 (Internal)	FGD Wastewaters Including Gypsum Slurry Wastewaters from Units 1,2, and 4 FGD system	Ash Pond
112 (Internal)	IUCS (Illinois University Conversion System) sump from Unit 3 FGD system	Ash Pond
3, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15A, 16, 18, 19, 20, 22, 23, 25, 26, 27, 28, 29, 30, & 31	Stormwater	Lick Creek and White River

[1] The ash pond (Outfall No. 001) includes treated sanitary wastewater (Internal Outfall No. 101), water treatment system wastewater, demineralizer wastewater, condensate polisher wastes, non-chemical metal cleaning wastes from Units 1-4 condensers, coal pile run-off, oil/water separator wastewater, low volume wastes, Units 3 and 4 boiler blowdown, cooling tower overflows/blowdown, dewatering bins wastewater, ash trench underdrain discharges, miscellaneous plant drains, fire protection deluge systems water, various water storage tank overflows, air pre-heater wash, carbon filter wastewater, coal conveyance water extraction wastewater, limestone area run-off, yard drains, general plant stormwater, truck tire wash water, gypsum dewatering waste, screen backwash water, river dredging materials, FGD system discharges, bottom ash handling wastewater from all units, and fly ash handling wastewater.

TABLE 2-5
Petersburg Generating Station NPDES Permit Limits for Outfall Nos. 001 (Ash Pond System Discharge), 007 (FGD Sludge Disposal Site Runoff), and Monitor & Report Requirements of Outfall Nos. 111 and 112 (FGD Discharges)[1]

		Outfall No. 001 (Ash Pond)[1]			Outfall No. 007 (FGD Sludge Disposal Site Runoff)[1]		
Parameter	**Units**	**Effective Date[3]**	**Monthly Average**	**Daily Maximum**	**Effective Date[3]**	**Monthly Average**	**Daily Maximum**
Boron[2]	mg/L	Oct. 2012	Report	Report	Final (Sep. 2017)	8.3	14.0
Cadmium[2]	mg/L	Final (Sep. 2017)	0.002	0.0035	Final (Sep. 2017)	0.002	0.0035
Chromium[2]	mg/L	Oct. 2012	0.19	0.19	Oct. 2012	Report	Report
Copper[2]	mg/L	Interim (Oct. 2012)	0.2 [4]	0.2[4]	Oct. 2012	Report	Report
	mg/L	Final (Sep. 2017)	0.022	0.039		--	--
Iron[2]	mg/L	Oct. 2012	1[4]	1[4]	Oct. 2012	Report	Report
Lead[2]	mg/L	Final (Sep. 2017)	0.0085	0.015	Final (Sep. 2017)	0.0085	0.015
Mercury[2]	ng/L	Final (Sep. 2017)	12	20	Final (Sep. 2017)	12	20
Nickel[2]	mg/L	Final (Sep. 2017)	0.1	0.24	Oct. 2012	Report	Report
O&G	mg/L	Oct. 2012	9 [4]	13 [4]	Oct. 2012	15.0	20.0
pH	S.U.	Oct. 2012	--	6.0 to 9.0 [4]	Oct. 2012	--	6.0 to 9.0
Selenium[2]	mg/L	Final (Sep. 2017)	0.033	0.057	Final (Sep. 2017)	0.033	0.057
TSS	mg/L	Oct. 2012	29 [4]	95 [4]	Oct. 2012	30.0	100.0
Sulfate	mg/L	Final (Sep. 2017)	1500	2600	Final (Sep. 2017)	1500	2600
Zinc[2]	mg/L	Interim (Oct. 2012)	0.95 [4]	0.95 [4]	Oct. 2012	Report	Report
	mg/L	Final (Sep. 2017)	0.20	0.35		--	--
TRC	mg/L	Interim (Oct. 2012)	0.13 [4]	0.2 [4]		--	--
	mg/L	Final (Oct. 2013)	0.01 [5]	0.02 [5]		--	--

[1] Outfall No. 001 has report-only requirements for ammonia as N, arsenic, boron, biochemical oxygen demand (BOD), cadmium (interim), chlorides, cyanide, flow, fluoride, lead (interim), manganese, mercury (interim), nickel (interim), phosphorus, selenium (interim), sulfate (interim), and total dissolved solids (TDS).

Outfall No. 007 has report-only requirements for ammonia as N, arsenic, BOD, boron (interim), cadmium (interim), chlorides, chromium, copper, cyanide, flow, fluoride, iron, lead (interim), manganese, mercury (interim), nickel, phosphorus, selenium (interim), sulfate (interim), TDS, and zinc.

Outfall Nos. 111 and 112 (FGD), not shown, have report-only requirements for ammonia as N, arsenic, boron, BOD, cadmium, chlorides, chromium, copper, flow, iron, lead, manganese, mercury, nickel, oil & grease, pH, phosphorus, selenium, TDS, TSS, thallium, and zinc. The report-only requirements take effect on the date of permit issuance.

[2] The identified metals are as total recoverable.

[3] The NPDES Permit requires compliance with the final permit limits for Outfall Nos. 001 and 007 no later than October 1, 2015, which was extended to September 29, 2017, in the AO for Case No. 2013-21497-W. Interim limits apply until the final limits become effective.

[4] Derived from TBEL. Other limits presented in the table are WQBELs.

[5] The Final total residual chlorine (TRC) limit on Outfall No. 001 takes effect 12 months from the permit effective date.

mg/L = milligrams per liter
ng/L = nanograms per liter
O&G = oil and grease
S.U. = Standard Units
TRC = total residual chlorine

2.2.2 Stormwater Requirements (NPDES Permit Conditions I.D and I.E)

These requirements are similar to the stormwater requirements that apply to the Harding Street facility (Section 2.1.2).

In December 2012, ERM issued a stormwater Review Findings Report that assessed structural and non-structural controls and addressed compliance gaps associated with NPDES Permit Condition I.D (ERM, 2012a). To ensure compliance with this permit condition, IPL plans to make the following modifications for the Petersburg facility. It should be noted that the years shown are tentative and subject to change:

1. Install an additional storage building for gypsum. This runoff flows to Outfall No. 007. The compliance strategy evaluation for this Outfall is described in Section 7.2 and Appendix D of this CSP.
2. IPL will cover the landfill for stormwater runoff. Sampling data to date has shown moderate risk for noncompliance based on historical erosion and associated run-off issues. This runoff flows to Outfall No. 007. The compliance strategy evaluation for this Outfall is described in Section 7.2 and Appendix D of this CSP.
3. Improve dust suppression - river water supply fill station for Water Truck. This activity is planned for 2014-2017.
4. Street sweeper purchase and use (such as to clean up fly ash off ground in loading area). This activity is planned for 2014-2017.
5. Add miscellaneous road paving and sediment control structures such as silt fencing, straw bales, or erosion control matting. This activity is planned for 2014-2017.
6. Update inspection forms. Make them consistent with the information required for the routine inspections and comprehensive inspections. This activity was completed in 2012-2013.
7. Clarify with IDEM the intent of Permit Condition No. I.D.4.j. This activity was completed in 2013.
8. Revise and update the SWPPP. This activity was completed in 2012-2013.

IPL's plans to construct a building over the gypsum pile and cover the landfill (as well as plan to construct a building over the IUCS (Illinois University Conversion System) pile) to comply with Section I.A.5 will also support compliance with permit condition I.D.

2.3 Existing Effluent Limits - Eagle Valley Generating Station

NPDES Permit No. IN0004693 issued to the IPL Eagle Valley Generating Station on August 28, 2012, contains the effluent limits and/or monitoring requirements for ash pond effluent, once-through non-contact cooling water, oil water separator wastewater, and stormwater (Outfall No. 003); once through non-contact cooling water and stormwater (Outfall No. 002); and the internal ash pond discharge (Outfall No. 103). There are no new outfall discharge limits in this permit that warrant changes to the existing treatment.

Stormwater limits, which include for the first time non-numeric effluent limitations, are also included in the permit. Stormwater Requirements (NPDES Permit Conditions I.D and I.E)

These requirements are similar to the stormwater requirements that apply to the Harding Street and Petersburg facilities, Eagle Valley NPDES Permit Condition I.D contains the same stormwater non-numeric effluent limits and requirements.

In December 2012, ERM issued a stormwater Review Findings Report that assessed structural and non-structural controls and addressed compliance gaps associated with NPDES Permit Condition I.D (ERM, 2012b). To ensure compliance with this permit condition, IPL has committed to making the following modifications for the Eagle Valley facility:

1. Clean the spill and rust stains from the floor in the maintenance hut at the north side of the plant. This activity was completed in 2013 and has been included as part of the regular job duties of coal-handling personnel.
2. Clean and remove coal dust from around the railroad tracks and stormwater ditches. This activity was completed in 2013 and has been included as part of the regular job duties for coal handling personnel.
3. When fly ash is removed from ponds and placed in trucks for transport, further minimize fugitive emissions and ash spills: clean the loading area after each load or spill and do not load trucks when wind conditions are

ATTACHMENT DHF-1
CAUSE NO. 44540

unfavorable. This activity is an ongoing implementation of SOPs, which were developed and implemented in 2013.

4. Update inspection forms. Make them consistent with the information required for the routine inspections and comprehensive inspections. This activity was completed and implemented in 2012-2013.
5. Clarify with IDEM the intent of Permit Condition No. I.D.4.j. This activity was completed in 2013.
6. Revise and update the SWPPP. This activity was completed in 2012-2013.

SECTION 3

Compliance Gap Evaluation Based on Existing Wastewater Treatment System

3.1 Harding Street Generating Station

3.1.1 General Facility Description

The IPL Harding Street Generating Station is designated as a Major NPDES permitted facility and is classified under Standard Industrial Classification (SIC) Code 4911-Electric Services.

The facility is a coal- and oil-fired steam electric generating plant located in the Upper White River watershed (USGS 05120201) within the White River Basin. The plant generates electricity using three coal-fired units (Units 5, 6, and 7), which commenced operation in 1958, 1962, and 1973, respectively. The generator rating of coal fired Units 5, 6, and 7 is 106 MW, 106 MW, and 427 MW, respectively. Wastewater generated from the operation of the coal-fired units discharges via Outfall No. 006 to Lick Creek. The facility also has an emergency diesel unit and six gas- and/or diesel-fired combustion turbines, which are not associated with any water discharges.

The Harding Street Generating Station uses once-through cooling water from the river for Units 5 and 6 (which is discharged through Outfall Nos. 001, 002, and 005).

The Harding Street Generating Station's Unit 7 has two closed-cycle cooling towers.

Both bottom ash and fly ash are sluiced to an onsite wastewater treatment pond system for storage. Additionally, all coal-fired units have dry fly ash handling systems as a partial method of handling fly ash. Cooling tower blowdown from Unit 7 cooling towers discharges to the onsite ash pond system. All coal-fired units are equipped with electrostatic precipitators and Unit 7 is equipped with a wet FGD system, all of which generate wastewaters that are discharged through Outfall No. 006 via the ash pond system.

The ash pond system discharges via Outfall No. 006 to Lick Creek, and ultimately to the White River. Outfall Nos. 001 and 002 discharge once-through non-contact cooling water from the once-through cooling towers 5 and 6 when they are in operation, to the White River.

3.1.2 Existing Wastewater Conditions and Treatment System

The station's regulated outfalls were summarized in Table 2-1. At the time of this report, most of the wastewater from the Harding Street Station is discharged to Lick Creek through a series of ponds that provide settling prior to discharge. These ponds include the cinder pit, ash ponds, and various on-site stormwater retention basins. Lick Creek flows into the West Fork of the White River. Some cooling water is discharged directly to the West Fork of the White River, without entering the pond system. Units 5, 6, and 7 are coal-fired units generating wastewater. IPL retired Units 3 and 4 in 2013. IPL plans to either close Units 5 and 6 or convert them to natural gas prior to the September 2017 NPDES compliance date.

The plant currently has some dry fly ash handling capacity, but some fly ash does have to be sluiced wet to the ponds because of capacity constraints in the dry system. The pond system discharges to Outfall No. 006. It receives wastewaters from a number of sources including fly ash transport water, bottom ash transport water, FGD system blowdown, low-volume wastewater streams, Unit 7 cooling tower blowdown, and non-chemical metal cleaning wastewater. The key sources are summarized in the design basis (see Appendix B).

Treatment currently provided to discharge at Outfall No. 006 includes sedimentation and the site has approval for use of chemical neutralization.

3.1.3 Existing Discharge Water Quality Compliance Gap Evaluation

Existing wastewater data from Discharge Monitoring Reports (DMRs) and a water use study performed by GE from October 2011 to May 2012 were used initially to evaluate wastewater quality. Data gaps were identified, and additional data and information was obtained through wastewater sampling by CH2M HILL and IPL and interviews with plant staff. DMR data was compared to interim and final limits as presented in Appendix B's Table 3 for the Harding Street Generating Station. Several parameters exceed interim and/or final limits, requiring treatment or source control.

3.1.3.1 Ash Pond Discharge Water Quality

Final Permit Limits

The continued discharge from the ash pond represents a high compliance risk because, based on DMR data, several parameters exceed final permit limits in some samples over the past year. This is shown in Appendix B's Table 3. These included mercury, selenium, copper, iron (based on current operational exceedances) and possibly cadmium. The final permit limits become effective in September 2017. Therefore, new and/or additional treatment and/or management will be necessary in order to comply with these final NPDES permit limits.

Current Compliance Concerns

IPL's Harding Street Generating Station's NPDES permit includes daily maximum and monthly average limits on iron of 1 milligram per liter (mg/L) for Outfall 006 (ash pond discharge) effective October 2012. IPL exceeded the permit limit for iron during the months of January, February, May and December of 2013.The permit also includes interim copper limits of 0.03 mg/L (monthly average) and 0.06 mg/L (daily maximum), effective October 2012. IPL exceeded the monthly average permit limit for copper during the month of September 2013.

3.1.3.2 FGD Wastewater

Currently, FGD wastewater is not treated prior to entering the pond system. The current permit contains a new internal FGD outfall (Outfall No. 101) with associated M&R requirements.

Other NPDES Outfalls

There are no new limits included in the current permit for the other NPDES outfalls (Outfall Nos. 001, 002 and 005), however new M&R requirements were added. No additional treatment needs, at the other permitted outfalls are being considered at this time other than Outfall No. 006 and potentially in the future at Outfall No. 101.

3.1.4 Key Sources of Pollutants of Compliance Concern

The key wastewater sources of pollutants associated with the above compliance gaps are included in **Appendix B**.

3.1.5 Projected Water Quality if Refueled to Natural Gas - Compliance Gap Evaluation

The wastewater produced from Harding Street if converted to natural gas will require treatment to ensure compliance with the NPDES permit limits on TSS and mercury. Cooling tower blowdown (the source of most the wastewater in a gas-fired Harding Street scenario) concentrates the TSS in the river water by the number of cycles of concentration the tower performs at. This can result, especially during rain events when the river has high TSS, in cooling tower blowdown in the hundreds of mg/L. The monthly average limit is 30 mg/L TSS. Also, cooling tower blowdown exceedances of mercury, due to concentrating up the mercury in the river water, is considered a moderate-high risk.

3.2 Petersburg Generating Station

3.2.1 General Facility Description

The IPL, Petersburg Generating Station is designated as a major NPDES permitted facility and is classified under SIC Code 4911- Electric Services. The facility is a coal-fired steam electric generating plant located on the main stem of the White River; 1.5 mile northeast (upstream) of the State Road 61 Bridge at Petersburg, and approximately 1 mile south of the confluence of the East and West Fork White River. The plant generates electricity using four coal-fired units (Units 1, 2, 3, and 4) which commenced operation in 1967, 1969, 1977, and 1986, respectively.

Wastewater generated from the operation of the coal-fired units discharges via Outfall No. 001 to Lick Creek. The Petersburg Generating Station uses once-through river cooling water for Units 1 and 2, which is discharged through

Outfall No. 002 to the White River. Unit 2 has the capability to utilize a half-sized cooling tower (helper tower) which means that it has the capability of operating in a closed-cycle cooling water mode to reduce half of the "waste heat" from Unit 2. Petersburg Generating Station's Units 3 and 4 are closed-cycle cooling water systems. There are two water intake structures at the facility. The intake structure for Units 1 and 2 is located along the White River on the west side of the facility. The intake structure for makeup water for Units 3 and 4 is located on the Discharge Canal (not considered a water of the state or a water of the Unites States).

Both bottom ash and fly ash are sluiced to an onsite wastewater treatment pond system for storage (all units have dry fly ash handling systems as the primary method of handling fly ash; however, there are times when fly ash is sluiced to the onsite ash pond system). Based on the previous permit, cooling tower blowdown from ½ -sized Unit 2, Units 3 and 4 could be discharged through Outfall Nos. 005, 006 and 008, or to the Ash Pond System. Per the renewal permit application, all the discharge pipes from Outfall Nos. 005, 006, and 008 to Lick Creek are currently disconnected. Cooling tower blowdown from the half-sized Unit 2, Units 3 and 4 currently discharge to the ash pond system. However, IPL wants to be able to reconnect the discharge from cooling tower blowdown from these units through Outfalls 005, 006, and 008 in the future. Therefore, Outfall Nos. 005, 006, and 008 are maintained in the permit.

The FGD sludge disposal site run-off discharges through Outfall No. 007 to Lick Creek.

3.2.2 Current and Planned Wastewater Conditions and Treatment System

The station's regulated outfalls were summarized in **Table 2-4**. At the time of this report, most of the wastewater from the Petersburg Station is discharged through Outfall No. 001 to Lick Creek through a series of ponds that provide settling prior to discharge. These ponds include ash ponds and various on-site stormwater retention basins. Lick Creek flows into the White River. Some cooling water is discharged directly to the White River, without entering the pond system. The pond system receives wastewaters from a number of sources including fly ash water, bottom ash transport water, FGD system blowdown, low-volume wastewater streams (including Units 2, 3, and 4 cooling tower blowdown), and non-chemical metal cleaning wastewater. The key sources are summarized in the design basis (**Appendix C**).

The plant currently has some dry fly ash handling capacity, but some fly ash does have to be sluiced wet to the ponds due to equipment limitations (Majority associated with Units 1 and 2 based on operator log sheets).

Outfall No. 007 receives mostly runoff that may have contacted CCR material – such as runoff from the IUCS pile, an outdoor pile of solids from Unit 3, which includes calcium sulfite and fly ash; runoff from the landfill which has interim cover material of Poz-o-Tec; as well as wheel wash wastewater. These waters also flow through a series of ponds prior to discharge to Lick Creek.

Treatment currently provided for wastewater flowing to Outfall No. 001 is sedimentation (settling out solids) in ash ponds. Treatment processes that the site has approval to use for wastewater flowing to Outfall No. 007 include sedimentation and neutralization.

3.2.3 Existing Discharge Water Quality Compliance Gap Evaluation

Existing wastewater data from DMRs and a water use study performed by GE from October 2011 to May 2012 were evaluated initially. Data gaps were identified, and additional data and information was obtained through wastewater sampling by CH2M HILL and IPL and interviews with plant staff. DMR data were compared to interim and final limits as presented in Appendix C's Tables 3 and 4, respectively, for the Petersburg Generating Station.

3.2.3.1 Ash Pond and Outfall No. 007 Discharge Water Quality

Final Permit Limits

The continued discharge from the ash pond represents a high compliance risk because, based on DMR data, several parameters exceed final permit limits in some samples over the past year. The final permit limits become effective in September 2017. This is shown in Appendix C's Tables 3 and 4. This comparison on DMR data to future limits indicates that for Outfall No. 001, treatment for mercury, cadmium, selenium, iron, TRC, and sulfate likely would be required. And for Outfall No. 007, treatment or source control for boron, sulfate and mercury may be required (though each had values above future limits in only a small percent of samples). Therefore, new and/or additional treatment and/or management will be necessary in order to comply with these final NPDES permit limits.

Current Compliance Concerns

IPL's Petersburg Station's NPDES permit includes daily maximum and monthly average limits on iron of 1 milligram per liter (mg/L) for Outfall 001 (ash pond discharge) effective October 2012. IPL exceeded this permit limit during the months of October 2012 and January 2013.

The Petersburg NPDES permit requires monitoring for total residual chlorine (TRC) weekly and includes final limits on TRC at Outfall No. 001, which became effective October 1, 2013. The permit states that the discharge limit for TRC is less than the limit of quantitation (LOQ) of 0.06 mg/L. If the effluent concentration is less than the LOQ, then the result complies with the permit. However, if the sample result is above the discharge limit and limit of detection (LOD), 0.02 mg/L, in any three consecutive analyses or any five out of nine analyses, then IPL is required to re-examine chlorination /dechlorination procedures and increase sampling and analysis for TRC. IPL monitoring of TRC, prior to the effective date of the limit, led IPL to proactively do additional sampling and evaluation of current chlorination/dechlorination processes/ procedures. Therefore, modifications to the system was evaluated in order to minimize NPDES non-compliance risk.

3.2.3.2 FGD Wastewater

Currently, FGD wastewater is not treated prior to entering the pond system. However, the current permit contains a new internal FGD outfall (Outfall Nos. 111 and 112) with associated M&R requirements.

3.2.3.3 Other NPDES Outfalls

There are no new limits included in the current permits, and therefore no additional treatment needs, at the other permitted outfalls other than Outfall Nos. 001 and 007, and potentially in future at Outfall Nos. 111 and 112.

3.2.4 Key Sources of Pollutants of Compliance Concern

The key wastewater sources of pollutants associated with the above compliance gaps is included in **Appendix C**.

SECTION 4

Compliance Strategies Considered

As a result of the compliance gaps identified in Section 3 of this CSP, the project team evaluated wastewater compliance strategies including but not limited to several different treatment technologies, source elimination, outfall relocation to a receiving water body with a higher flow, and water reuse. This section describes the approach to evaluation of these strategies.

4.1 Overall Approach Determination

The current wastewater management approach at both stations is to co-manage most process wastewater (other than once-through cooling water) in pond-based treatment. After determining that the current wastewater management approach, including the discharge of individual or combined streams, is not adequate to meet the new NPDES permit limits, CH2M HILL considered whether wastewater streams should be treated combined or segregated. It was determined that the process wastewaters at each station should be separated into three wastewater groups: 1) FGD water, 2) ash transport water, 3) other wastewaters. Additionally, at Petersburg a fourth wastewater group is the CCR-contact stormwater run-off that flows to Outfall No. 007. This approach was chosen because:

- FGD water is recommended for three-group segregated management because FGD water is a concentrated, lower-flow source of several of the trace metals that have NPDES permit limits, treating it separately represents an opportunity for lower-flow and therefore lower-cost treatment.
- Ash and Other wastewater streams are recommended to be treated separately from each other. The team determined that conversion to dry fly ash handling offered a lower risk and lower cost than treating the fly ash water to NPDES discharge limits either by itself or combined with other streams. Additionally, because fly ash contributes corrosive anions to water (such as chlorides and sulfate), reuse of fly ash water was not recommended. Segregation of bottom ash water from Other water is recommended as it will allow the bottom ash water to be reused since it is lower in corrosive salts than the remaining wastewaters (which have significant concentration of salts from cooling tower blowdown and source water treatment residuals). The remaining wastewaters (i.e., non-CCR containing water) can be managed and treated with fewer regulatory requirements than if ash-containing (CCR) water is included.

4.2 Water Quality of Individual Wastewater Streams

To evaluate which pollutants would need to be removed to meet discharge limits, CH2M HILL compared available effluent water quality data for individual wastewater streams to the permit limits. This is shown for Harding Street in Appendix B's Table 4 and for Petersburg in Appendix C's Tables 4 and 5. At both stations it was determined that the FGD wastewater, the Fly Ash transport water, and the Other wastewater will require additional treatment beyond settling in order to comply with the final NPDES permit limits. The bottom ash transport water has some compliance risk at each site if treated only by settling using the existing ash pond systems.

4.3 Wastewater Management Alternatives Evaluated

Wastewater management alternatives were developed by first evaluating which of these three wastewater groups (FGD, Ash, and Other) were causing the regulated plant outfalls to have metals concentrations above the new NPDES permit limits. This evaluation showed that treatment is needed, and identified which streams required treatment for which metals. Alternatives were then evaluated by considering the various treatment options for each of the three wastewater streams (FGD, Ash, and Other). Alternatives included treatment, water reuse, and outfall relocation. The primary wastewater management options evaluated included:

- Relocating the wastewater discharge to the White River to obtain higher permit limits;
- Dry fly ash handling to eliminate fly ash water;

- Pond treatment;
- Enhanced pond (adding chemicals to improve precipitation and clarification of pollutants with liner);
- Tank-based physical/chemical treatment (including Closed-loop Bottom Ash sluicing using remote drag chain dewatering systems);
- Advanced treatment for selenium removal by biological or zero valent iron (ZVI);
- Thermal zero liquid discharge (ZLD) systems (with and without recycling) (The FGD ZLD option was refined during the project to reduce costs to include recycling a portion of the FGD water.); and
- Recycling water within the plant to reduce or eliminate discharge.

The technologies are described in the following sections. Additional information on each technology is provided in **Appendices B and C**. The team evaluated various combinations of the various compliance options for the three wastewater groups, resulting in evaluating over 35 permutations of options.

4.3.1 Discharge Relocation

The project team evaluated the relocation of combined or individual wastewater streams to the White River. The White River has a substantially higher flow than the current receiving waterbody (Lick Creek), which may provide some relief from certain water quality based effluent limits.

Discharge relocation will not affect compliance with technology-based limits in the pending ELGs – such as numeric limits anticipated on FGD water, or possible prohibition on ash transport water discharge.

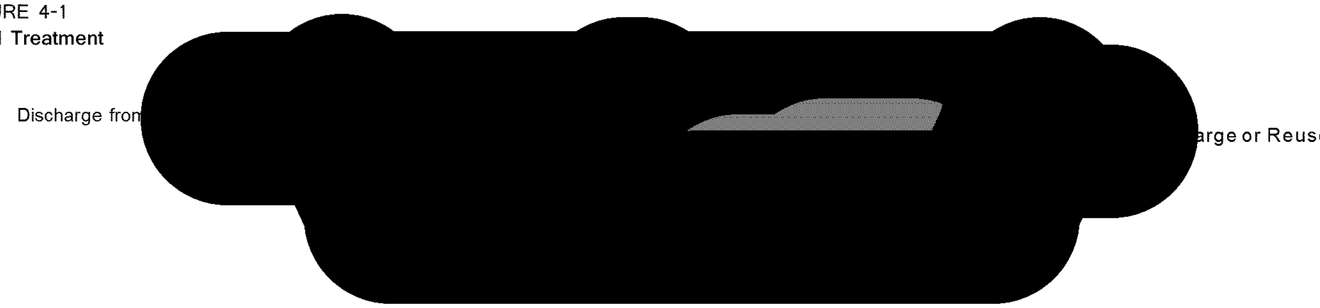
4.3.2 Dry Fly Ash Handling

Transport of fly ash to silos, from the location where it can currently be trucked to reuse or disposal, can be accomplished through a variety of systems using vacuum, pressure, or combined vacuum/pressure systems. Petersburg and Harding Street Stations currently have some dry ash handling capacity which can be further built upon to eliminate all fly ash sluice water.

4.3.3 Pond Treatment

Pond treatment systems are a traditional way of treating wastewater. **Figure 4-1** shows the pond treatment process. Solids will accumulate in the pond reducing the settling depth and potentially the settling area, until the pond is dredged. The volume required for solids accumulation should be built into the design of the pond. Ponds provide residence time and quiescent conditions which allow solids to settle out of the water. Advantages of pond treatment are: lower capital cost, minimal operational costs, and ability to equalize flow surges. CH2M HILL determined that the existing pond treatment will not be a sufficient treatment system to meet the new NPDES permit limits if all wastewaters continue to flow to the ponds. Therefore, the treatment option of all wastewater continuing to go combined to the current ponds is not considered feasible and is eliminated from further considerations and discussions. However, this treatment option was evaluated for purposes of treating bottom ash and is discussed further in Sections 6.2.3 and 7.2.3.

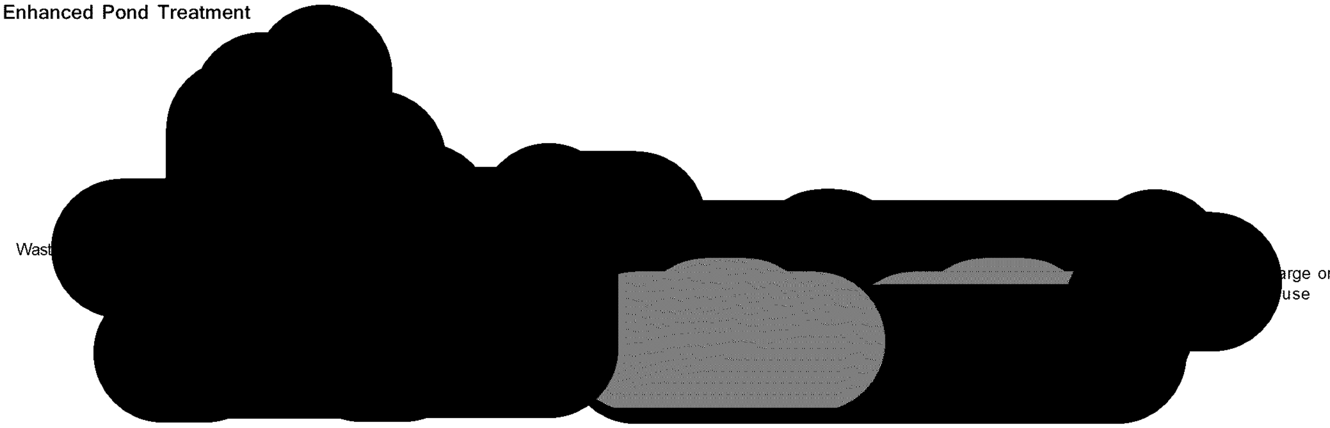
FIGURE 4-1
Pond Treatment



4.3.4 Enhanced Pond Treatment

Enhanced pond treatment systems are fundamentally the same as traditional pond treatment systems except they utilize chemical additives to improve treatment by converting some soluble contaminants to particulate form, and by making particles bigger. Aeration can be added for mixing and driving chemical reactions towards oxidation, such as converting ferrous iron produced in cleaning operations to ferric iron (which would then precipitate out of solution). **Figure 4-2** shows an example of the enhanced pond treatment process. The settled solids in the enhanced pond system will need to be removed by dredging. This treatment option may include a liner depending on the type of wastestream.

FIGURE 4-2
Enhanced Pond Treatment

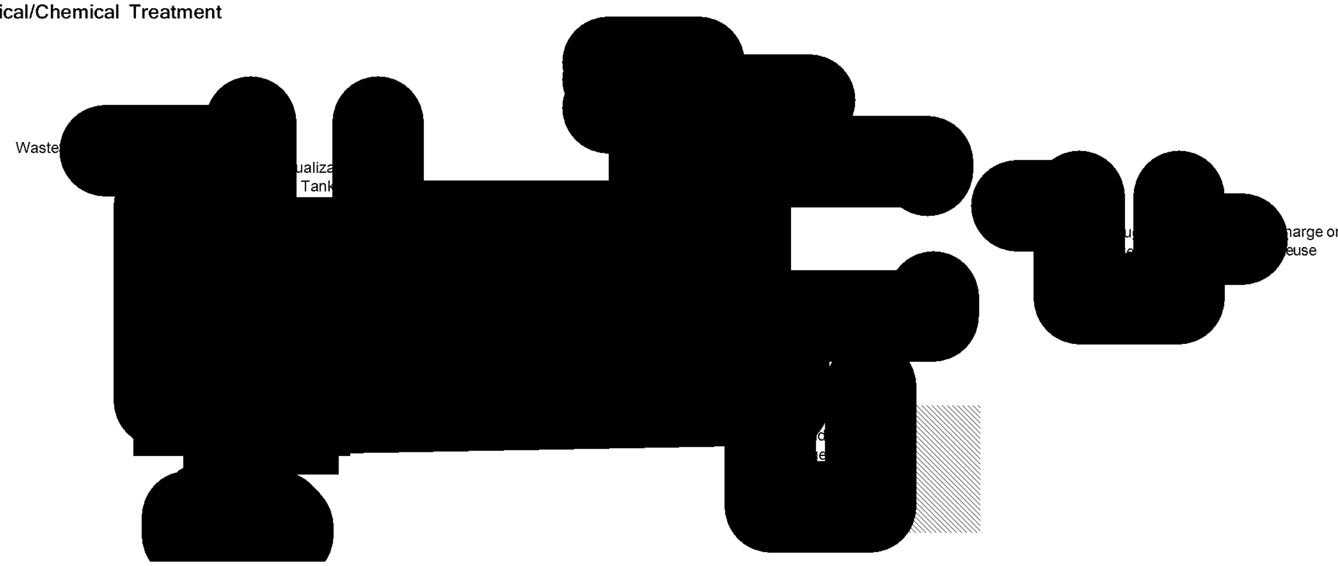


4.3.5 Tank-based Physical or Physical/Chemical Treatment

Tank-based physical treatment typically includes gravity-settling of solids using a clarifier. The system may also include chemical feed systems and mix tanks to convert dissolved forms of metals into particulate metals that can be removed by settling or filtration. Chemicals for coagulation and flocculation may be added as well. This is typically termed Chemical Precipitation or Physical/Chemical Treatment.

Figure 4-3 shows a typical treatment system. Clarification removes suspended solids and particulate metals that settle faster than the design settling velocity of the clarifier. Because the surface area of a clarifier is typically smaller than that of a pond, the clarifier has a higher overflow rate. Therefore, in order to settle out small solids, the process includes adding coagulants to agglomerate smaller particles into larger ones that can be removed by settling in the clarifier. Typical chemicals used in physical/chemical treatment include coagulants such as iron salts like ferric chloride. Organosulfides typically are added to aid in metals precipitation, since most metal sulfides are very insoluble. Acids or caustics are added to adjust pH to improve chemical precipitation. The system evaluated for this project used polymers in conjunction with ferric chloride to create larger particles from small particles. Other treatment chemicals may be added as needed. Solids settled out in the clarifier must be dewatered and disposed of.

FIGURE 4-3
Physical/Chemical Treatment

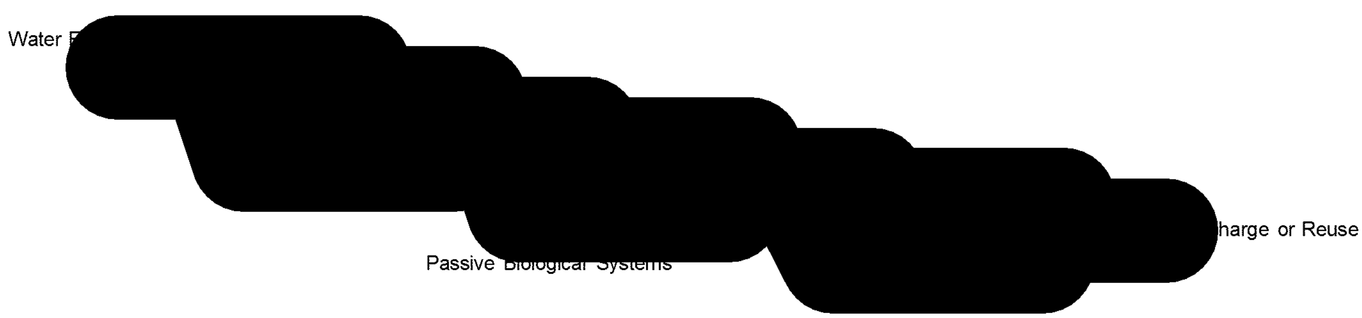


4.3.6 Passive Biological Treatment

Passive biological treatment is similar to tank-based biological treatment described below, but typically relies on the substrate in the system for carbon source, while active systems have nutrient pumped in. Selenium is reduced to elemental selenium, as well as organic forms of selenium, which are then sequestered in the organic substrate. Eventually the organic substrate including selenium is removed and disposed of. Heavy metals can also be removed in passive systems. **Figure 4-4** shows a typical treatment system. Passive biological treatment removes nitrate-nitrogen from wastewaters. This treatment also acts as a polishing step for metals after physical/chemical treatment. Solids would need to be removed by physical/chemical treatment prior to entering the system in order for treatment to be achieved. This technology has limited full-scale systems in the power industry. There are two such systems in service on power plant FGD wastewater in the U.S. (FGD treatment at one Duke Energy station and one Alabama Power station).

The land required for anoxic, anaerobic and aerobic treatment was estimated to be a minimum of 18 acres for Harding Street and 30 acres for Petersburg for removal of selenium and nitrate sufficient to get selenium removal (including redundancy, separating berms and support equipment). The proposed ELGs would require an extremely low level of nitrate and nitrites. Passive biological treatment generates organic nitrogen compounds in excess of the low nitrate and nitrite limits proposed in the ELG, which would require additional active biological treatment after typical passive treatment systems, increasing cost and land area required considerably. Based on land requirements, moderate-high risk of noncompliance with selenium limits, and issues associated with nitrate and nitrite limits, passive treatment was not considered further.

FIGURE 4-4
Passive Biological Treatment



4.3.7 Tank-based Biological Treatment

Tank-based biological treatment systems are composed of tanks filled with solid media that support bacterial growth. The process includes adding an organic carbon source or electron donor to the wastewater to support the bacterial processes. The bacterial processes reduce nitrate/nitrites to nitrogen which releases from the water. The bacteria then use selenite or selenate as their source of oxygen or electron acceptor, biochemically reducing them to elemental particulate selenium. The bacteria also take oxygen from sulfates in the water, generating sulfide, which can precipitate mercury.

Biological treatment systems include two categories: fixed-film and suspended growth. Fixed-film includes the GE ABMet™ process, as the only full-scale application of this technology for FGD water treatment is the GE ABMet™ process, which is used at six power plants (Duke Energy and American Electric Power). The systems have not all consistently shown compliance with the selenium limits on FGD water in the proposed ELG. Nor have they served at plants requiring FGD treatment to such low pollutant levels to meet end-of-pipe discharge limits as is required by the IPL NPDES permit final limits on a range of parameters.

Suspended growth biological treatment includes Infilco Degremont's iBIO® process. It is in use at one facility full-scale, the Conemaugh Generating Station in Pennsylvania. Data is not available to show if it is consistently meeting the 10 ppb selenium limit of the proposed ELG.

A pilot system of tank-based physical/chemical treatment followed by biological treatment (GE ABMet) was tested in 2013 using Petersburg's FGD water. The pilot system ran at steady state for 13 weeks, and the team collected 26 samples for various laboratory analyses. The discharge of the pilot system did not comply with the limitations set by the NPDES permit for Outfall 001. Cadmium, iron, sulfate, boron, mercury, and TSS concentrations had results greater than the Monthly Average limits at Petersburg's Outfall 001. To comply with the Outfall 001 limits, the FGD wastewater stream will require dilution from other sources of wastewater or additional treatment, such dilution is planned with the "Other water" group and possibly Bottom Ash wastewater. Analysis of the pilot effluent data in combination with data collected for the "Other" wastewater streams indicates that mercury, copper, sulfate, boron, and TSS have a risk of noncompliance with the Outfall 001 limitations set by the new NPDES permit. And if the pilot effluent data is combined with "Other" wastewater and Bottom Ash wastewater, data indicates that mercury, copper, cadmium, sulfate, boron, and TSS have a risk of noncompliance with the Outfall 001 limitations set by the new NPDES permit. However, it was recognized from early in the project that discharging treated FGD water would have a risk of non-compliance with the sulfate limit for Outfall No. 001 and potential future boron limit and therefore relocation of the discharge to increase these limits would be necessary if FGD treatment and discharge was chosen. However, as discussed in Section 7.1, discharge relocation was not evaluated further due to cost and risk considerations.

However, there is uncertainty about the long-term performance of this treatment system. There is a low to moderate risk of NPDES non-compliance for selenium limits, and a low to moderate probability of risk of future ELG compliance needs. During this limited period, the pilot test results showed that the system was in compliance with proposed ELG limits (arsenic, mercury, nitrate and nitrite, and selenium).

Figure 4-5 shows an example of a tank-based biological treatment system. Tank-based biological treatment also acts as a polishing step for mercury after physical/chemical treatment. This treatment poses a moderate risk of operator reliability problems related to multiple processes and requires more operator attention to monitor and adjust the chemical feed systems.

Fluidized bed reactor (FBR) and moving bed bioreactor (MBBR) are other types of fixed-film tank-based biological treatment. CH2M HILL considered FBR and MBBR in the second step of the screening process. In an FBR, water is passed through a granular solid media at a high enough velocity to suspend, or fluidize, the media creating a reactor configuration for attached growth. The FBR is seeded with heterotrophic facultative bacteria that are suited for nitrate and selenium removal. In an MBBR, water is passed through a tank with suspended growth activated sludge. The sludge biomass is augmented by biocarriers which provide surface area for growth of additional heterotrophic facultative bacteria needed for nitrate and selenium removal. The effectiveness of these technologies is uncertain as they have never been used in a full-scale FGD system. An alternative biological system configuration is suspended growth. There is one such system in full-scale service for selenium treatment from FGD water in the United States. Therefore, these types of fixed-film tank-based biological treatment systems were not further evaluated as they are not proven treatment technologies for FGD wastewater.

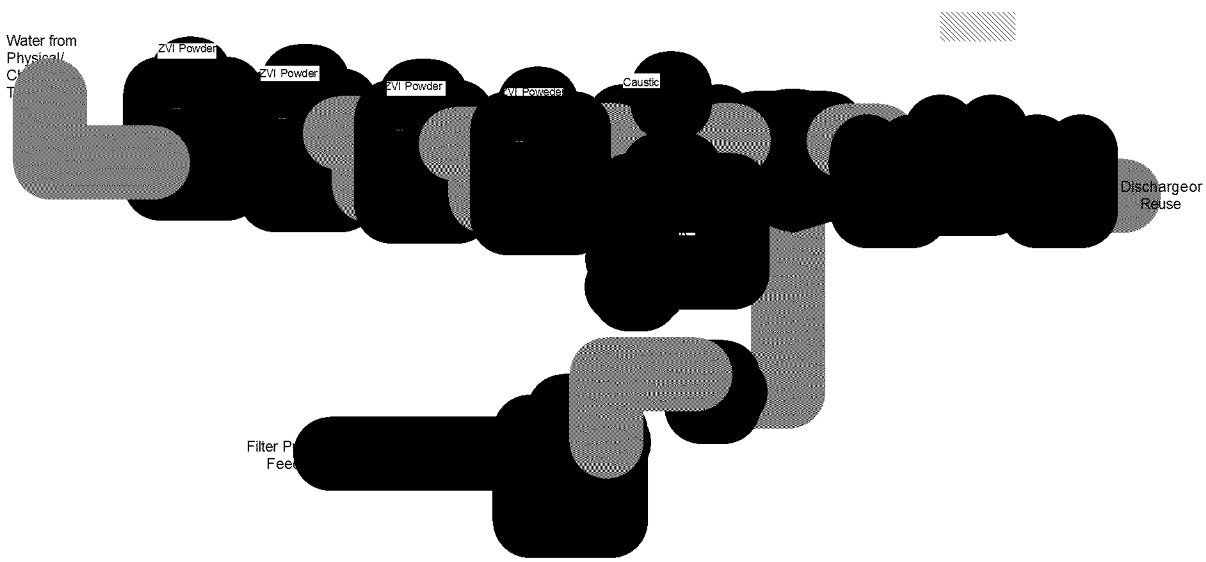
FIGURE 4-5
Tank-based Biological Treatment

4.3.8 Zero Valent Iron

Zero valent iron (ZVI) uses small solid particles of iron added to water in mix tanks, which are oxidized to ferrous iron, while chemically reducing selenate to selenite or elemental selenium, which can be removed from solution using iron co-precipitation. Passivation of the ZVI particle surface occurred in previous work, increasing the ZVI dose required. However, this was reduced or eliminated by a process recently developed by Texas A&M University and licensed to Siemens. **Figure 4-6** shows an example of a ZVI treatment system.

IPL contracted with Siemens to conduct ZVI lab-scale shaker test. The test did result in significant reductions of selenium, mercury and nitrate. However, most of the nitrate was converted to ammonia. If this process was implemented, there is a high probability of an ammonia limit being adding to the permit, and a risk of non-compliance with this limit. In addition, the technology is in the process of being tested on a limited pilot scale basis. The supplier is planning a demonstration scale test. However, there were no results available during this IPL project. Therefore, due to concerns with ammonia formation and the lack of commercialization, this technology was eliminated from consideration as it is not considered technically proven.

FIGURE 4-6
Zero Valent Iron Treatment



4.3.9 Zero Liquid Discharge by Thermal Treatment

There are two thermal ZLD treatment alternatives typically considered for wastewater management in the power industry. In the first, the wastewater is fed to an evaporator to distill off water producing two streams:

- Evaporator distillate, which can be reused in the power plant (recycled to the FGD system, or may be used in other high purity uses in the power plant if the ELGs allow it)
- Evaporator brine to be mixed with fly ash and transported offsite for disposal in a landfill

The wastewater may or may not be softened prior to evaporation. In the second level of ZLD, the brine is then fed to a crystallizer, which further reduces the brine to a salt cake that can be disposed of. This treatment option requires a significant amount of electricity and/or steam. **Figure 4-7** shows an example of a thermal ZLD treatment system which produces brine for fly ash wetting.

FIGURE 4-7
Zero Liquid Discharge by Thermal Treat[redacted]

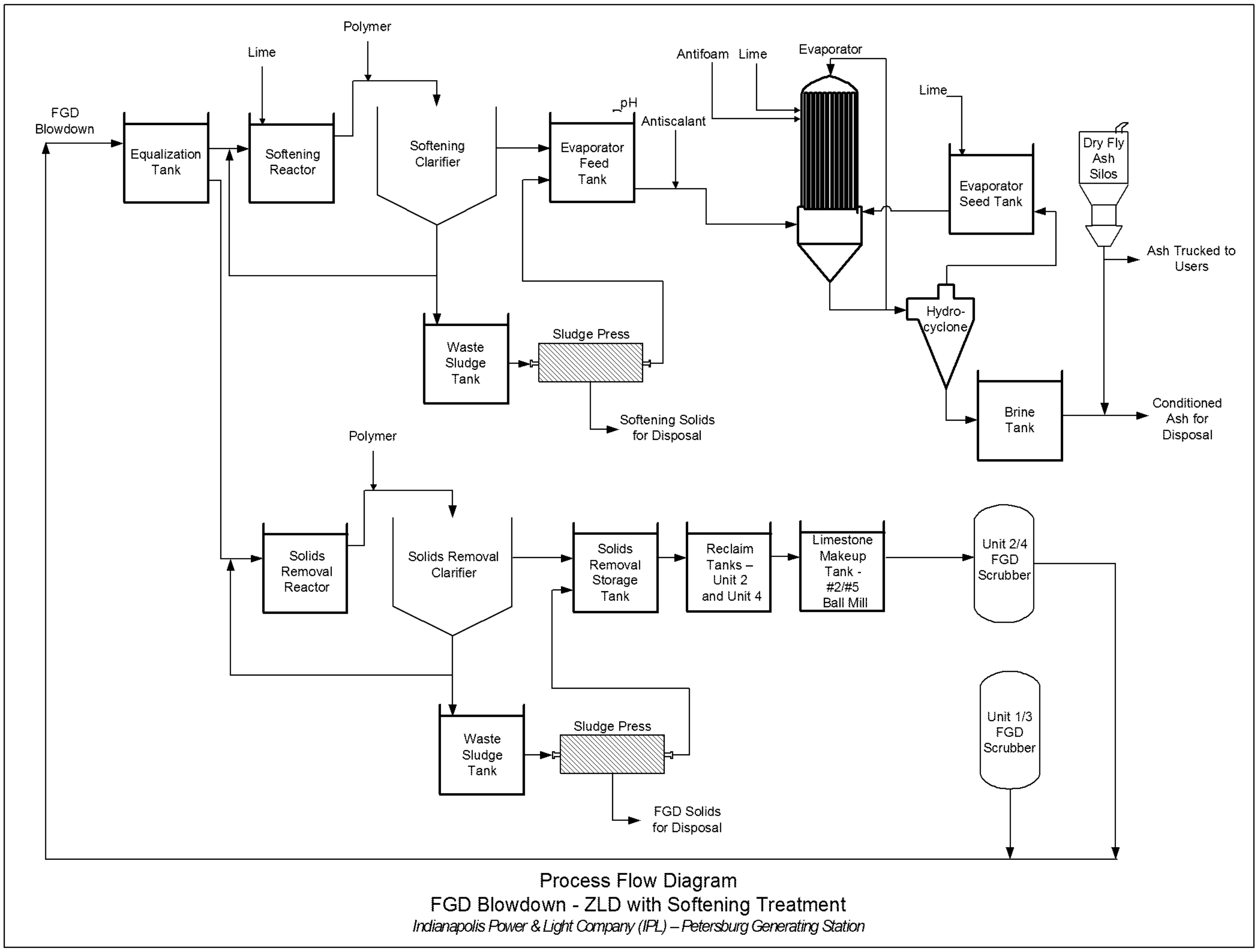
4.3.10 Zero Liquid Discharge by Thermal Treatment with Recycle

The thermal ZLD option was refined during the project to include recycling a portion of the FGD water, which lowered the cost of this option. The flow of FGD system blowdown at both the Harding Street and Petersburg stations is driven by fine solids content rather than chlorides. A "ZLD with Recycle" approach was developed in which blowdown is split into two streams: a portion of the FGD wastewater is treated by physical/chemical treatment (clarifier) and then recycled to the FGD system. A smaller portion of FGD wastewater is treated with softening and evaporation, producing two liquid streams as described above.

Figure 4-8 shows an example of a ZLD treatment system with recycle.

FIGURE 4-8

Zero Liquid Discharge by Thermal Treatment with Recycle



4.3.11 Zero Liquid Discharge by Reuse

Reusing water in the plant can reduce or eliminate wastewater streams. Wastewater best suited for reuse are those from processes that contribute little or no salts that can cause corrosion or scaling, such as bottom ash sluicing.

SECTION 5

Compliance Strategy Considerations and Potential Risks

Project considerations and potential risks beyond the current NPDES permit were evaluated for the compliance strategy alternatives for the IPL Harding Street and Petersburg Generating Stations and are included in the following sub-sections. While the outcome and timing of pending regulations and requirements remain unknown, possible risks due to noncompliance with potential future regulations and requirements were considered to ensure selection of an adaptable, flexible, and well-planned compliance strategy.

5.1 Future NPDES WQBELs

Indiana Department of Environmental Management (IDEM) noted that they did not have sufficient data to conduct a Reasonable Potential to Exceed (RPE) analysis for several parameters, and included monitor and report (M&R) requirements in the permit to collect additional data. IDEM may revise the monitoring requirements and/or limits after 12 months of data are collected if requested by IPL or if IDEM determines that there is a reasonable potential to exceed water quality standards. There is a reasonable possibility that Boron may be a future WQBEL for both Harding Street Station Outfall No. 006 and Petersburg Outfall No. 001 based on current operation and discharge effluent data. Boron is not treated by the physical/chemical or biological treatment processes being considered to meet other discharge limits. Therefore, a limit necessitating removal of boron would drive a need for ZLD management of the major source of boron (FGD wastewater).

5.2 Effluent Limitation Guidelines (ELGs)

EPA is currently in the process of updating the ELGs for the steam electric generating industry. The project included identifying and filling any data gaps associated with compliance with potential future regulation under the ELGs, identifying any pollutants that may not currently be in compliance with potential future regulation under the ELGs, and completing a screening evaluation of feasible and cost-effective wastewater management and treatment options to achieve compliance with potential future regulation under the ELGs.

The Proposed ELG was published in June 2013, and the Final Rule is currently anticipated to be issued by September 30, 2015. While IDEM states in the NPDES permit that the permit can be modified to comply with any applicable effluent limitation or guideline. The new ELG limits will likely be incorporated during the next renewal of IPL's permits which is anticipated in the fall of 2017. The Proposed ELG provides insights on what the Final ELG might require, but there is uncertainty on which requirements the EPA will choose for the Final ELG. The Proposed ELG issued by the EPA has a range of possible requirements, which are summarized as four "preferred options for existing sources" by EPA. These options indicate that EPA is considering the following requirements in the updated ELG. The probability of impact is based on current operating conditions.

- Fly ash transport water (High probability of significant impact)– Prohibit discharge (in all preferred options of the proposed ELG, so industry views as likely). Would necessitate changing fly ash system at both sites so that no wet sluicing is done.
- Bottom ash transport water(Moderate probability of significant impact) – Proposed ELG includes two possible options: prohibit discharge of bottom ash transport water, or a requirement to meet current Best Practicable Technology (BPT) limits on low-volume wastewater (total suspended solids, oil and grease [O&G], and pH). If discharge banned then bottom ash water would need to be reused in the power plant.
- Landfill leachate (Moderate probability of low impact risk). – Compliance point with technology-based limits equal to current limits on low-volume wastewater (total suspended solids, O&G, and pH). There is a risk that the Final ELG will expand the definition of leachate to include runoff from CCR landfills. The impact is considered low

because the Proposed ELG's compliance requirements for leachate waters from existing sources was on TSS, oil & grease and pH, not BAT metals limits.

- Non-chemical metal cleaning waste – Clarification of ELG requirements (low probability of a significant impact to IPL facilities). Some uncertainty because EPA's definition of NCMC is not clear, need clear definition from final ELG and then NPDES permit to verify understanding that there will be no impact on IPL stations.
- Flue gas mercury control (FGMC) wastewater - Prohibit discharge (in all preferred options). It is possible that the final ELG rule may indicate that washes of portions of the flue gas emission control system (such as air preheater washes) may be considered a flue gas mercury control, the project team believes that air pollution control equipment (such as air preheaters, economizers, and precipitators) washes are not flue gas mercury control and rather will be considered non-chemical metal cleaning wastes. This is based on the proposed ELG rule, specifically pages 34450 and 34451 of the Federal Register which states, "The ELGs define metal cleaning waste as 'any wastewater resulting from cleaning [with or without chemical cleaning compounds] any metal process equipment, including, but not limited to, boiler tube cleaning, boiler fireside cleaning, and air preheater cleaning." The ELG then also describes metal cleaning wastes as including economizer wash, mechanical dust collector cleaning, and precipitator wash. Therefore, it appears EPA's initial intention is to include this type of stream as a NCMC wastewater; however, final determination will be rendered by IDEM.
- Low-volume wastewater - streams such as cooling tower blowdown, process sumps, water treatment residuals, etc. have technology-based limits in the existing ELG. These limits are not anticipated to change with the upcoming final ELG revision.
- FGD water (High probability of significant impact) – Proposed ELG includes two possible options: Compliance point with technology-based limits on FGD water prior to mixing with other wastewater. Limits set on mercury, arsenic, selenium, and nitrate/nitrites (Table 5-1), or permit writers use best professional judgment (BPJ) to set limits on FGD water. These limits would necessitate FGD treatment for trace metals (physical/chemical treatment) and selenium and nitrate/nitrite (biological treatment or ZLD).

TABLE 5-1
Limits on FGD Water in Proposed ELG (June 2013)

Parameter	Units	Monthly Average	Daily Maximum
Arsenic, total	mg/L	0.006	0.008
Mercury, total	ng/L	119	242
Selenium, total	mg/L	0.010	0.016
Nitrate/Nitrite, total	mg/L	0.13	0.17

ng/L = nanograms per liter

5.2.1 Current FGD Water Quality Compared to FGD Water Limits in Proposed ELG – Harding Street

Table 5-2 shows a comparison of historical FGD water quality data and the potential ELG limits on FGD wastewater. The data shown in this table are mostly from DMR monitoring, which was required starting in October 2012. The filtered results are from sampling done by CH2M HILL in October and November 2012. The four parameters limited in the proposed ELGs are present, even after filtration, at levels above the proposed limit, indicating that treatment beyond settling will be needed to achieve compliance.

TABLE 5-2
FGD Wastewater at Harding Street Generating Station Compared to Proposed ELG Limits
Monitoring Data from September 2012 to July 2013

Parameter	Proposed ELG Limits		Historical Monitoring		% of Samples Above Daily Limit
	Monthly Avg	**Daily Max**	**Avg**	**Max**	**%**
Arsenic , mg/L					
Total	0.006	0.008	0.33	1	96%
Filtered[1]	--	--	0.024	0.029	100%
Selenium, mg/L					
Total	0.010	0.016	0.9	1.5	100%
Filtered[1]	--	--	0.66	0.76	100%
Nitrate/Nitrite, mg/L					
Total	0.13	0.17	28	44	100%
Mercury, ng/L					
Total	119	242	19,251	35,500	100%
Filtered[1]	--	--	4,815	7,600	67%
TSS, mg/L[2]	30	100	6,702	13,274	N/A[2]
Oil & Grease, mg/L	15	20	5	17	0%
pH, s.u.[3]	--	6.0 to 9.0	6.0 to 7.4		0%

Notes:
Red highlighted cells indicate values that are greater than half the proposed limit.
[1]All filtered data is from separate CH2M HILL testing preformed in 2012 (not part of NPDES compliance monitoring)
[2] TSS is mostly removed through settling in the existing ash pond.
[3]pH shows minimum and maximum

5.2.2 Current FGD Water Quality Compared to FGD Water Limits in Proposed ELG – Petersburg

Tables 5-3 and **5-4** give the historical average and maximum concentrations of parameters that will be regulated at the FGD wastewater compliance point. The information shown in the tables are derived from DMR monitoring data, which were required starting in October 2012 for this specific outfall. Outfall 111 is comprised of filtrate and associated wastewater from FGD gypsum dewatering operations for Units 1, 2, and 4. Outfall 112 is comprised of wastewaters from IUCS dewatering operations and Unit 3 FGD scrubber blowdown.

TABLE 5-3
FGD Wastewater (Outfall 111) at Petersburg Generating Station Compared to Proposed ELG Limits
Monitoring Data from October 2012 to September 2013

Parameter	Proposed ELG Limits		Historical Monitoring		% of Samples Above Daily Limit	% of Samples Above Monthly Average Limit
	Monthly Avg	**Daily Max**	**Avg[3]**	**Max**	**%**	**%**
Arsenic , mg/L						
Total	0.006	0.008	0.02	0.06	89%	89%
Selenium, mg/L						
Total	0.01	0.016	0.10	0.26	95%	95%
Nitrate/Nitrite, mg/L						
Total	0.13	.017	--	--	--	--
Mercury, ng/L						
Total	119	242	3,600	14,200	89%	89%
TSS[1], mg/L	30	100	3,223	15,245	N/A[1]	N/A[1]
Oil & Grease, mg/L	15	20	<5	<5	0%	0%
pH, s.u.[2]	--	6.0 to 9.0	7.4 to 8.3		0%	0%

TABLE 5-3
FGD Wastewater (Outfall 111) at Petersburg Generating Station Compared to Proposed ELG Limits
Monitoring Data from October 2012 to September 2013

Parameter	Proposed ELG Limits	Historical Monitoring	% of Samples Above Daily Limit	% of Samples Above Monthly Average Limit

Notes:
Red highlighted cells indicate values that are greater than half the proposed limit.
-- = No data for this pollutant.
1 TSS is mostly removed through settling in the existing ash pond.
2pH minimum and maximum values are presented.
3This average is the average of all sampling results, not the highest monthly average value, which would be more directly comparable to a Monthly Average limit. There are limited data for which more than one sample was collected in a month. Thi s overall average is done to give sense of 'typical' wastewater.

TABLE 5-4
FGD Wastewater (Outfall 112) at Petersburg Generating Station Compared to Proposed ELG Limits
Monitoring Data from October 2012 to September 2013

Parameter	Proposed ELG Limits		Historical Monitoring		% of Samples Above Daily Limit	% of Samples Above Monthly Average Limit
	Monthly Avg	Daily Max	Avg[3]	Max	%	%
Arsenic , mg/L						
Total	0.006	0.008	0.08	0.27	100%	100%
Selenium, mg/L						
Total	0.01	0.016	0.59	1	100%	100%
Nitrate/Nitrite, mg/L						
Total	0.13	.017	--	--	--	--
Mercury, ng/L						
Total	119	242	2634	6510	100%	100%
TSS[1], mg/L	30	100	18123	169700	N/A[1]	N/A[1]
Oil & Grease, mg/L	15	20	3.6	15	0%	0%
pH, s.u.[2]	--	6.0 to 9.0	5.6 to 7.5		8%	N/A[1]

Notes:
Red highlighted cells indicate values that are greater than half the proposed limit (or outside pH range).
-- = No data for this pollutant.
1 TSS is mostly removed through settling.
2pH minimum and maximum values are presented.
3This average is the average of all sampling results, not the highest monthly average value, which would be more directly comparable to a Monthly Average limit. There are limited data for which more than one sample was collected in a month. This overall average is done to give sense of 'typical' wastewater.

5.3 Final 316(b) Rule

Pending 316(b) rules may require IPL to construct additional cooling towers as a method of reducing intake flows and complying with this regulation. This would create more cooling tower blowdown to be managed in compliance with NPDES limits. The Petersburg "Other Water" treatment system has been sized to accommodate additional cooling tower flow from adding cooling towers to Petersburg Unit 1 (and increasing towers on Unit 2). At this time, IPL believes there is low risk that 316(b) will trigger the need for a closed-cycle cooling system for Harding Street Units 5 and 6 based on the proposed rule. However, this rule is not final and will be evaluated further upon final promulgation.

5.4 Final 316(a) Rule

Pending CWA 316(a) IDEM guidance may affect IPL's approval of variances from thermal effluent limits such that closed cycle cooling is required. This would create more cooling tower blowdown to be managed in compliance with NPDES limits. The Petersburg "Other Water" treatment system has been sized to accommodate additional cooling tower flow from adding cooling towers to Petersburg Unit 1 (and increasing towers on Unit 2). At this time, IPL believes there is low risk that 316(a) will trigger the need for a closed-cycle cooling system for Harding Street Units 5 and 6 based on the past alternative thermal effluent limits (ATELs). However, IPL plans to perform an updated thermal demonstration study commencing in 2014 and upon completion of this study, this issue will be further evaluated.

5.5 CCR Final Rule

Coal Combustion Residuals (CCR) management may be affected by regulation or possibly legislation. EPA issued a Draft CCR Rule in June 2010, but its progress has been stalled. This rule will potentially either require ponds containing CCRs (such as ash and FGD solids) to be closed, or will require the ponds to have a composite liner, leachate collection, groundwater monitoring, risk evaluations based on location, and closure plans that would make them much more expensive. IPL has previously done a study on the Draft CCR Rule of 2010. This study determined that in order to comply with the Rule as proposed IPL would be required to phase out the use of CCR ponds. The final rule may impact continued use of existing ash pond units and/or enhanced ponds which treat any form of CCR wastewaters.

5.6 Changes to Wastewater Due to Mercury and Air Toxics Standards

Both Harding Street and Petersburg Stations will have changes made to their air emission controls to meet MATS regulations. The changes for MATS compliance at Harding Street include adding activated carbon injection (ACI) for mercury control, upgrading the Electrostatic Precipitator (ESP) for particulate matter and hazardous air pollutants (HAPs) control, FGD reliability improvements for acid gas control, and additional air monitoring. The changes for MATS compliance at Petersburg include: adding ACI and sorbent injection (SI) for mercury control, adding baghouses on Units 2 and 3, completing Units 1 and 2 FGD reliability improvements for acid gas control, and additional air monitoring. These MATS changes may affect the stations' top ash and FGD wastewaters characteristics or treatability, although the effects have not been quantified.

SECTION 6

Compliance Strategy Evaluation – Harding Street Station

This section summarizes the evaluation of compliance opportunities determined to be technically feasible for the IPL Harding Street Station. **Appendix B** contains additional information on the selection process, including decision grids used in early selection phases.

6.1 Discharge Relocation at Harding Street Station

CH2M HILL evaluated the option to relocate the discharge to the White River. Since the water quality based limits are based on discharge to a near-zero low-flow creek (i.e., Lick Creek), there may be an opportunity to obtain some relief from these limits by relocating the discharge. To this end, CH2M HILL calculated the projected effluent quality and WQBELs for three White River discharge scenarios: 1) Outfall No. 006, 2) Outfall No. 006 without any ash transport water (fly ash or bottom ash), and 3) Outfall No. 006 without fly ash transport water (including bottom ash). However, these discharge options did not result in effluent limit increases sufficient to reduce the required treatment strategies. In particular, the White River offers only a small increase to discharge limits for key parameters (e.g., selenium) compared to the Lick Creek limits, hence treatment of selenium would still be required. Therefore, discharge relocation is not feasible for purposes of overall compliance, nor does it provide significant reduction of risk or overall cost of compliance.

6.2 Wastewater Treatment and Reuse

CH2M HILL evaluated the technologies described in Section 4 for each of the three wastewater groups (FGD, Ash, and Other). The evaluation and selection of compliance strategy was completed through several steps of eliminating options. CH2M HILL developed Class 5 cost estimates for each of these remaining alternatives. The detailed analysis is provided in **Appendix B** including cost estimates. It should be noted that alternatives that were screened out in early rounds of the selection process did not have their cost estimates updated or refined in later rounds of evaluation.

Table 6-1 provides a summary of the alternative evaluation and selection. The alternatives shown are those remaining after screening out those that were considered to have a high probability of NPDES non-compliance risk (such as no biological or ZLD treatment of FGD water), and those considered to have excessive cost because lower-cost options provided sufficient treatment to meet the NPDES permit limits (such as selenium biological or ZLD treatment for the Other water group). The evaluation of the wastewater groups is described in the following subsections and in **Appendix B**. More information on the selected alternative is provided in Section 8.

CH2M HILL used a design basis in evaluating compliance alternatives based on the characteristics of contributing wastewater streams. The critical elements include wastewater flow and water quality. The project team used peak daily flow, expressed in gpm, to size treatment systems in this evaluation. **Appendix B** provides additional design basis information.

6.2.1 Compliance Strategy for Permit's Iron Limit and Interim Copper Limit

The current NPDES permit has a 1.0 mg/L limit for iron and an interim limit for copper of 0.03 mg/L monthly average at Outfall No. 006 effective October 2012. The station is currently having challenges consistently complying with these limits. The recommended compliance strategy is to install a chemical addition and aeration system to the existing pond system. This would be located at the point where water flows into Pond 3. This system would include:

- Polymer addition at the Pond 3 inlet at the pipes between Pond 4B and Pond 3, including:
  - Polymer-blending system

- Sump pump to convey water from near the polymer feed system to the polymer-blending system to make-up polymer solution
- Air addition for mixing in the pipes
- Platform to allow access to the pipes
- Storage building to house equipment and polymer

• pH adjustment in the Unit 7 Waste Pit discharge pipe during Unit 7 air heater washes

• Organosulfide addition at the Cooling Tower, including:

- Organosulfide metering pumps

TABLE 6-1
Summary of Alternative Evaluation – Harding Street Generating Station

Recommended compliance strategy shown in green highlighting

Water Group	Strategy	Risk of Non-Compliance with Limits in Current Permit[3]	Likelihood of Noncompliance with Future Regulations [6]	Cost at Time of Alternative Selection [4] Capital ($M)	O&M ($M/yr)	10-Yr NPV ($M)
				Costs for entire Compliance strategy (as of October 2013)		
FGD water	FGD by physical/chemical plus biological treatment [1]	Moderate	High – future WQBEL limits Low - ELG limits	$123	$4.8	$155
	FGD by ZLD; with recycle	None[5]	None	$116	$4.0	$143
	FGD by ZLD; no recycle	None[5]	None	$132	$6.2	$173
Fly ash transport water	Dry fly ash handling	None	None	$30 [9]	$0.5	$33 [9]
	Wet fly ash handling, treat in ponds, discharge	High	High - CCR rule and ELG rule	Cost estimates not developed for treatment because the use of existing pond system even with chemicals will not meet the NPDES permit limits.		
	Wet fly ash handling, treat in tank-based physical/chemical treatment, discharge	High	High - ELG rule			
				Costs for Bottom Ash strategy		
Bottom ash transport water	Tank-Based Dewatering and Reuse	None	None	$26	$0.47	$29
	Treat in Existing Ponds with new chemical and aeration addition and Discharge	Low to Moderate[7]	High as is High from CCR rule and moderate from ELG rule[2]	$0.5	$0.39	$23 [2]
				Costs for Other Water strategy		
Other water	Tank-Based physical/chemical treatment, discharge	Low/Moderate (selenium)	Low-Moderate[8]	$15	O&M costs are similar between options	See Capex
	Enhanced Pond physical/chemical treatment, discharge	Low/Moderate (selenium, mercury) Risks increase if 4B taken out of service (TSS, Fe, Hg)	Low/moderate - CCR rule	If Pond 4B stays in service: $16 [10] If not: $11 [10]		

Notes:

[1] Several configurations of biological treatment (and zero valent iron) were evaluated before GE ABMet was chosen as the selenium treatment option to evaluate against ZLD. Described further in **Appendix B**.

[2] Continuing to treat bottom ash water in ash ponds, with addition of chemical feed system to mitigate risk, would not achieve compliance with the CCR Rule as proposed due to requirement to close or line ponds. It also would not be expected achieve compliance with the ELG Rule as proposed due to a potential ban on bottom ash transport water discharge. NPV assumes pond-based with chemical feed in 2017 and then adding tank-based treatment three years later (a rough estimate of CCR compliance schedule, based on currently available information). Based on proposed ELG rule, compliance is anticipated in late 2017. Only relatively low capital cost is required for this compliance strategy, which allows IPL to, at a minimum, delay additional cost until more certainty exists around the outcome and timing of future regulations. Fly ash conversion to dry handling is scheduled to be done before the CCR rule requires closure or lining of ponds.

[3] The possibility of new limits if Outfall No. 006 relocated to White River were considered in assessing risk. Relocation did not offer much relief at Harding Street. Risks are assigned as: None (if wastewater stream is eliminated), Low, Moderate, or High likelihood of non-compliance with the Final limits in the current NPDES permits.

TABLE 6-1
Summary of Alternative Evaluation – Harding Street Generating Station

Recommended compliance strategy shown in green highlighting

Water Group	Strategy	Risk of Non-Compliance with Limits in Current Permit[3]	Likelihood of Noncompliance with Future Regulations [6]	Cost at Time of Alternative Selection [4] Capital ($M)	O&M ($M/yr)	10-Yr NPV ($M)

[4] NPV calculated as capital cost plus first 10 years of operating cost (future operation depreciated assuming 8.25% interest rate). Costs in this table do not sum to the total NPDES Compliance cost because there are costs outside of the defined wastewater groups. Costs are shown for comparative purposes used in alternative evaluation.
[5] Some minor risk of final ELG putting "discharge" limits on the ZLD distillate if it used outside of the FGD system. If this o ccurs, operators will reuse the water in the FGD to avoid limits. Therefore, considered to not be a risk.
[6] Based on proposed regulations.
[7] Discharging bottom ash water at Harding Street is considered to have low -to-moderate risk of selenium non-compliance until actual water from Unit 7 sump can prove how much selenium dilution there will be. It is problematic to predict selenium concentrations until the change s to Unit 7 sump are made.
[8] Compliance plan is for bottom ash tank overflow wastewater (seal water) to flow to Other Water group. Because this water contains bottom ash, this may be determined to meet bottom ash transport water under the final ELGs and require modification to compliance strategy in the near future, in which case this seal trough water would instead be managed with Ash Water.
[9] Cost estimate includes a portion of the pipe rack run to the wastewater and fly ash areas.
[10] Cost estimate does not include additional pond system components IDEM explained in April 2014 meeting would be needed. If included, the cost of enhanced ponds would increase. (Those costs are reflected in Petersburg enhanced pond costs in Table 7 -1.)

6.2.2 Compliance Strategy Evaluation for Final Limits - Ash Water – Fly Ash

The recommended compliance strategy for fly ash water is dry fly ash handling to eliminate fly ash water.

Fly ash discharge, under current operations, presents a high risk of non-compliance with NPDES permit limits based on pollutant concentrations, most notably selenium and mercury if continued to send to the existing ash pond system. Because fly ash contributes corrosive anions to water (such as chlorides and sulfate), reuse of fly ash water was not considered as a technically feasible option. Therefore, treatment (including selenium treatment to meet NPDES limits) or source elimination is needed in order for the station discharge to meet the permit's discharge limits. Additionally, there is a high probability that the final ELG rule will likely ban the discharge of fly ash transport water. Dry fly ash handling was chosen rather than treatment because it offered a lower risk and lower cost than treating the fly ash water to NPDES discharge limits either by itself or combined with other streams. In addition, dry fly ash handling also eliminates the risk that changes due to MATS compliance (such as carbon injection) will change the fly ash water, therefore making it more difficult to treat to ensure compliance. Furthermore, IDEM's new antidegradation standard prohibits additional lowering of water quality if a waterbody is impaired. The White River at both the Harding Street and Petersburg Generating Stations is impaired for mercury in fish tissue. Because the MATS project will remove mercury from air emissions and capture that mercury as part of the fly ash, it is possible that IDEM could prohibit the increased loading of mercury to the White River associated with fly ash generated after the MATS controls are operational. Both IPL stations already have some infrastructure in place to handle ash dry, which assists in the elimination of wet fly ash handling.

6.2.3 Compliance Strategy Evaluation for Final Limits - Ash Water – Bottom Ash

The recommended compliance strategy for bottom ash is continued treatment in ash ponds, with addition of chemical feed and aeration to mitigate risk of NPDES non-compliance. This selection summarized in this section, is also described in **Appendix B** and **Appendix E**.

Bottom ash water typically has much lower concentrations of parameters regulated in the NPDES permit than does fly ash water. Early steps of the alternative evaluation screened out options with advanced treatment for these wastewaters because treatment for selenium or salts was not needed. This left a selection between: tank-based physical treatment plus recycling, tank-based physical/chemical treatment plus discharge, or pond treatment with discharge.

If ponds are used, the water will need to be discharged rather than recycled. This is because the net increase in water into the system due to precipitation would necessitate some wastewater discharge. There is some risk of non-compliance with the NPDES limits (described in Appendix B) but the addition of treatment chemicals should mitigate this to a low risk. This will be the same chemical addition system described for the current iron and copper limits (Section 6.2.1).

Use of enhanced ponds (new, lined ponds) for bottom ash was considered in the early phases of the project. However, it was rejected as a risk of spending significant capital (tens of millions of dollars) on treatment that may later become obsolete.

Based on the proposed CCR Rule, it is likely that ponds would need to be replaced later with tank-based treatment due to the potential CCR Rule requirements on ponds (to have liner, leachate collection, groundwater monitoring, etc.). It is also possible that discharge would need to be replaced with recycle if the final ELG bans discharge of bottom ash water. The time period until replacement will be driven by the timing and requirements of the CCR and ELG rules. The CCR rule is projected to be finalized in 2014 and the ELG rule is projected to be finalized in 2015. The compliance schedules are uncertain, but are currently anticipated to be 5 to 7 years from finalization of the CCR Rule, and 3 to 8 years from finalization of the ELG Rule. Because costs of replacing the pond with tank-based treatment are several years later than the 2017 NPDES compliance date, the net present value of the tank-based system is higher than the pond-based option. Further, relatively low capital cost is required for this compliance strategy, which allows IPL to, at a minimum, delay additional cost until more certainty exists around the outcome and timing of potential future regulations.

6.2.4 Compliance Strategy Evaluation for Final Limits - FGD Water

The recommended compliance strategy for FGD water is thermal ZLD with recycling.

FGD water contains levels of pollutants, most notably selenium and mercury that would require treatment in order for the station discharge to meet the NPDES discharge limits. It also contains high concentrations of parameters that may have WQBEL limits set in the future (as indicated by M&R requirements), such as boron. The proposed ELGs include limits on FGD water (mercury, arsenic, selenium, and nitrates/nitrites), which may require treatment to meet.

Physical/chemical treatment of FGD water has been shown to not remove selenium to the levels needed to meet the current permit's selenium limits, nor the proposed ELG's limits on selenium and nitrates/nitrites. Therefore, the following options were eliminated as they would likely result in non-compliance: pond, enhanced pond, or tank-based physical/chemical treatment. Treatment options that have shown some promise for selenium or nitrate/nitrite treatment but have not been used full-scale for FGD wastewater treatment were eliminated because of the compliance and operability risks of relying on an unproven technology. These included:

- ZVI, which was tested on IPL's FGD water at the bench scale level, where treatability testing showed an increase in ammonia concentrations. The technology is in the process of being tested on a limited pilot-scale basis at other sites. The supplier is planning a demonstration-scale test. However, there were no results available during this IPL project. Therefore, due to concerns with ammonia formation and the lack of commercialization, this technology was eliminated from consideration as it is not considered technically proven.
- Biological treatment in systems such as FBRs and MBBRs, which have not been used on FGD water.
- Passive biological treatment, which has been used on FGD water at only two power plants, with neither being used to meet limits as low as in the proposed ELG. The land requirements were also prohibitive. The proposed ELGs would require an extremely low level of nitrate and nitrites. Passive biological treatment generates organic nitrogen compounds in excess of the low nitrate and nitrite limits proposed in the ELG, which may require additional active biological treatment after typical passive treatment systems, increasing cost and land area required considerably. Based on land requirements, and issues associated with nitrate and nitrite limits, passive treatment is considered a moderate-high risk of NPDES noncompliance (selenium final limit in NPDES permit) and therefore was not considered further.

Rejection of those options left two alternatives considered feasible to select between for FGD water: treatment by physical/chemical plus ABMet tank-based biological treatment or thermal ZLD. The thermal ZLD option was refined during the project to include recycling some FGD water back into the FGD, which allowed for reducing the size and cost of the thermal ZLD equipment. This resulted in comparable costs between biological treatment and ZLD. CH2M HILL recommends thermal ZLD because it has lower risk and has comparable cost as biological treatment. Specific issues that made the biological treatment option risks higher include:

- Having a FGD discharge inherently creates risk of not meeting ELG limits on FGD water discharge, as compared to eliminating the discharge.
- Harding Street Station FGD water has higher level of nitrates and sulfates than most FGD water. The suitability for complying with NPDES limits using biological treatment cannot be assured without extensive pilot testing with Harding Street Station's wastewater. Biological treatment has risk that it would not meet future ELG limits, and would need to be replaced with ZLD. This represents a potential moderate-high risk of future regulation adaptability.
- Discharging FGD water will inherently have some risk of non-compliance with the NPDES permit final limits on trace pollutants, especially mercury and selenium.
- Future water quality limits:
  - Although Outfall No. 006 does not currently have a limit for boron, the Harding Street Station has a monitor and report requirement, and a limit is highly probable in the future similar to the Boron limits contained in the Petersburg NPDES permit. The current monitoring data collected starting in October 2012 is above the calculated limit for discharge to the White River and there is a high risk of future noncompliance with a boron limit if IPL pursues biological treatment and most cost spent on biological system could not be transferred to a ZLD system (technologies are two different systems with little overlapping parts).
  - Similarly, future water quality based limits, such as salinity, may not be met with FGD water treated by biological treatment and then discharged.
- There is risk that MATS will change the FGD wastewater chemistry, thereby affecting the levels of selenium removal that biological treatment can achieve and mercury removal that physical/chemical treatment can achieve, which may result in a higher risk of compliance with the NPDES permit limits if using biological treatment.

6.2.5 Compliance Strategy Evaluation for Final Limits - Other Water

The recommended compliance strategy for Other Water group is tank-based physical/chemical treatment.

Early steps of the alternative evaluation screened out most options for Other Water because they were believed to provide more treatment than needed in order to achieve compliance at a higher cost, leaving two alternatives to select between for Other water: treatment by tank-based physical/chemical treatment or enhanced pond treatment.

Early cost estimates (2012) showed pond-based treatment to be much lower cost, but as more information was obtained in 2013 due to further geotechnical investigation of the ash pond, the cost estimates for these options are cost competitive due to the cost of preparing Pond 4 and 4B to build the enhanced pond on Pond 4. There is not room on the site to build the enhanced pond other than on retired ash ponds. The cost of preparing Pond 4 for construction of an enhanced pond is higher if Pond 4B needs to be kept in service. If 4B is taken out of service there would be higher risk of solids carry-through and non-compliance. This risk could be mitigated by adding treatment chemicals.

Risks and considerations associated with enhanced pond treatment include:

- There is less cost certainty at this time because additional geotechnical information and the chosen means of construction could significantly increase or decrease costs from CH2M HILL's cost estimate based on preliminary information. EPC bids will be required to improve cost certainty.
- One potential advantage of building an enhanced pond on an out-of-service ash pond is that the new pond's underlying liner would form a portion of the closure of the former pond. However, there is a moderate-to-high risk of not getting such a closure plan approved within the timeframe that this NPDES wastewater system is needed and in the same design concept as proposed.
- There is a moderate probability of risk that the final CCR Rule will prohibit the use of ponds and/or contain location restrictions which may drive pond closure. If this occurs, the ponds would need to be replaced with tank-based treatment. However, if ponds only contain non-CCR wastestreams, then the probability of risk may be reduced if the final rule does not regulate these type of non-CCR surface impoundments. The compliance plan is for bottom ash tank overflow wastewater (seal water) to flow to Other Water group. Because this water contains bottom ash, this may be determined to meet the definition of bottom ash transport water under the final ELGs and require this seal trough water be managed with Ash Water.
- Pond-based treatment offers less treatment for mercury and other metals than tank-based. In some samples collected from the Unit 7 Waste sump, elevated concentrations of some metals were detected. The Unit 7 Waste sump receives wastewater from multiple sources including ash hopper overflow, demineralizer system flows, and area drains. It is believed that ash is sometimes a component of the wastewater streams that enter the sump. When the demineralizer systems discharge regeneration streams to the sump, metals from the ash are mobilized creating higher concentrations of metals. These concentrations are potentially greater than those that would typically be applied to pond-based treatment. This risk may be mitigated by replacing the current demineralizer ion exchange beds and reverse osmosis (RO) system with a new reverse osmosis system with mixed-bed polishing and self-neutralization. The current demineralizer practice consists of alternating regeneration with strong acids and bases. As a result, the pH in the sump alternates between acidic and alkaline conditions. Alkaline pH dissolves anionic metals such as arsenic and selenium. Acidic pH dissolves cationic metals such as mercury. The result is that these metals from flyash present in the Unit 7 Waste sump are dissolved during demineralizer regeneration. Adding a RO may reduce the need for regeneration chemicals. It is recommended that the design of a potentially new system include a sufficiently large neutralization tank volume such that the regenerant solutions would neutralize each other before discharge to the Unit 7 Waste sump. Reducing the pH swings through this self-neutralization may reduce the leaching of metals from fly ash present in the sump. The addition of a RO system is recommended for both enhanced pond and tank-based treatment options.

Based on our understanding of costs and risks, CH2M HILL recommends that tank-based treatment is the best approach to address this treatment need.

6.3 Wastewater Compliance if Units 5, 6, and 7 Converted to Natural Gas Fired

A wastewater compliance concept was developed for a scenario in which Harding Street's Units 5, 6, and 7 were converted to natural gas.

The wastewater produced from Harding Street if converted to natural gas will require treatment to ensure compliance with the NPDES permit limits on TSS and mercury. The primary driver of treatment system equipment and cost will be TSS. A treatment system built for solids removal includes clarifier, chemical mix tanks, and sludge dewatering. Adding mercury removal with organosulfide feed adds little to the capital costs. If future water quality results show that metals treatment is not needed, then operating costs could be reduced (by buying less organosulfide).

The wastewater treatment system to address these compliance concerns would include:

- A wastewater collection system of sumps, pumps, and pipes to transfer wastewaters from their points of generation to the treatment facilities.
- Treatment of "Other Water" streams with tank-based physical/chemical treatment.

A rough cost estimate for this concept is $23,000,000 capital cost (which includes $3,000,000 of estimating contingency), and $600,000/year annual operating cost. This estimate is considered a Class 4 cost estimate, as described in Section 8.4.

SECTION 7

Compliance Strategy Evaluation – Petersburg Station

This section presents the compliance alternatives including discharge relocation and wastewater reuse and/or treatment for the IPL Petersburg Station. **Appendix C** contains additional information, including decision grids used in early selection phases of the evaluation.

7.1 Discharge Relocation at Petersburg Station

Parallel to evaluating treatment needs to comply with the current NPDES permit, CH2M HILL also evaluated relocating the discharge to the White River. The water quality based limits are based on discharge to a near-zero low-flow creek (i.e., Lick Creek), and there may be an opportunity to obtain some relief from these limits by relocating the discharge. To this end, CH2M HILL calculated the projected effluent quality and WQBELs for the following six White River discharge scenarios:

1. Discharge of Outfall Nos. 001 and 007 to White River (includes bottom ash [BA] and fly ash [FA]);
2. Discharge of Outfall Nos. 001 and 007 to White River without Ash Transport Water (neither BA or FA);
3. Combined Discharge of Outfall Nos. 001 and 007 to White River (includes BA and FA);
4. Combined Discharge of Outfall Nos. 001 and 007 to White River without Ash Transport Water (neither BA or FA);
5. Discharge of Outfall Nos. 001 and 007 to White River without Fly Ash Transport Water (includes BA); and
6. Combined Discharge of Outfall Nos. 001 and 007 to White River without Fly Ash Transport Water (includes BA).

The results of the calculations are provided in **Appendix A**. In summary, two key compliance risks drive the potential opportunities offered by outfall relocation: boron at Outfall No. 001 and sulfate at Outfall No. 007. Relocating the discharges to the White River and obtaining less stringent permit limits may trigger an anti-backsliding review by IDEM and the EPA Region 5. In general, the term anti-backsliding refers to CWA statutory and regulatory provisions that prohibit the renewal, reissuance, or modification of an existing NPDES permit that contains effluent limitations, permit conditions, or standards less stringent than those established in the previous permit. However, there are exceptions to this rule. Historically, EPA Region 5 has determined that relocation of outfalls does not warrant exemption from this provision of the CWA and will not allow for relaxation of existing WQBELs. Therefore, the possibility of receiving a relaxation of the existing water quality based effluent limits based on outfall relocation is low and thus is considered a moderate-high risk compliance option.

Additionally, there is uncertainty associated with relocation of discharge to the White River since the new permit limits would not be known until after IDEM issues a revised permit, which would occur after IPL's AO schedule milestone for setting the compliance strategy (July 2014). This approach is subject to IDEM's agreement to the limits estimated as part of this project in **Appendix A** and issuance of a permit in a timeframe that meets IPL's CSP. IDEM has communicated previously to IPL not to depend on a permit as a compliance option. Therefore, there is a moderate risk that IPL will not obtain a permit that contains the expected limits in the timeframe needed. In addition, relocating the outfalls does not address potential compliance challenges associated with the proposed ELGs.

In order to assess a possible means to address the current risk and future risk, a two-phase approach was evaluated. In the first phase the discharge would be relocated to the White River to get relief on some WQBELs. Treatment would be required for metals (primarily mercury) and would be installed during the first phase. There is a risk of not meeting the mercury limits on a continuous basis using enhanced pond treatment. In the second phase, there is a high probability that the final ELG limits may need additional treatment systems based on the proposed Rule.

This strategy offered lower initial costs, however it possibly may only be temporary until the ELG rule becomes final which has a high probability to include selenium limits on FGD wastewater requiring biological treatment or ZLD. The time delay between the first and second phase would be driven by the final ELG schedule. The proposed ELG schedule currently calls for compliance at the next NPDES permit issuance after July 2017, which for IPL would be October 2017. While it is possible this ELG compliance date could occur later, for now it appears the ELG requirements may be within a few months of the current NPDES permit renewal schedule. Implementing in two phases would incur higher total costs than implementing in one phase. The rough estimate of this extra cost is over $20 million.

Therefore, this option was not further considered due to the cost and approvability and future regulatory adaptability risks associated with it.

7.2 Wastewater Treatment and Reuse

The project team evaluated the technologies described in Section 4 for each of the three process wastewater groups (FGD, Ash, and Other). The evaluation and selection of compliance strategy was completed through several steps of eliminating options. The detailed analysis is provided in **Appendix C,** including cost estimates. Treatment, reuse, and source elimination options were evaluated for the streams that flow to Outfall No. 007. These are summarized in **Appendix D**. CH2M HILL prepared Class 5 cost estimates for each of these remaining alternatives. It should be noted that alternatives that were screened out in early rounds of the selection process did not have their cost estimates updated or refined in later rounds of evaluation.

Table 7-1 provides a summary of the alternative evaluation and selection. The alternatives shown are those remaining after screening out those that were considered to have a high probability of NPDES non-compliance risk (such as no biological or ZLD treatment of FGD water), and those considered to have excessive cost because lower-cost options provided sufficient treatment to meet the NPDES permit limits (such as selenium biological or ZLD treatment for the Other water group). More information on the selected alternative is provided in Section 8.

CH2M HILL used the design basis in evaluating compliance alternatives based on the characteristics of contributing wastewater streams. The critical elements include wastewater flow and water quality. The project team used peak daily flow, expressed in gpm, to size treatment systems in this evaluation. **Appendix C** provides additional design basis information

7.2.1 Compliance Strategy for Permit's Iron Limit and TRC Limit

The current NPDES permit has a 1.0 mg/L limit for iron at Outfall No. 001 effective October 2012. The permit also has a limit on TRC at Outfall No. 001 effective October 2013 of 0.01 mg/L monthly average and 0.02 mg/L daily maximum. The station is currently having challenges consistently complying with the iron limit, and had TRC present before October 2013 that caused concern with meeting the limits that became effective October 2013. The recommended compliance strategy is to install a chemical addition and aeration system to the existing pond system. This would be located at the point where water flows into the Finishing Pond. CH2M HILL is conducting additional treatability testing in February 2014 to verify the type of treatment, and has used their best professional judgment to forecast where in the cost range of possible treatment options the final selected option will fall.

TABLE 7-1
Summary of Alternative Evaluation – Petersburg Generating Station

Recommended compliance strategy shown in green highlighting

Water Group	Strategy	Risk of Non-Compliance with Limits in Current Permit[3]	Likelihood of Noncompliance with Future Regulations [6]	Cost at Time of Alternative Selection [4] Capital ($M)	O&M ($M/yr)	10-Yr NPV ($M)
				Costs for entire compliance strategy (as of October 2013)		
FGD water	FGD by physical/chemical plus biological treatment [1]	Moderate	High – future WQBEL limits Low - ELG limits, based on pilot test	$209	$8.0	$263
	FGD by ZLD; with recycle	None[5]	None	$202	$7.4	$251
	FGD by ZLD; no recycle	None[5]	None	$236	$8.6	$294
Fly ash transport water	Dry fly ash handling	None	None	$2.4	N/A[8]	N/A[8]
	Wet fly ash handling, treat in ponds, discharge	High	High - CCR rule and ELG rule	Cost estimates not developed for treatment because the use of existing pond system even with chemicals will not meet the NPDES permit limits.		
	Wet fly ash handling, treat in tank-based physical/chemical treatment, discharge	High	High - ELG rule			
				Costs for Bottom Ash strategy		
Bottom ash transport water	Tank-Based Dewatering and Reuse	None	None	$43	$0.8	$48
	Treat in Existing Ponds with new chemical and aeration addition and Discharge[2]	Low	High as is High from CCR rule and moderate from ELG rule	$1.2	$0.74	$39 [2]
				Costs for Other Water strategy (as of May 2014)		
Other water	Tank-Based physical/chemical treatment, discharge	Low/Moderate (selenium)	None	$30	O&M costs are similar between options	Tank-based would have a future cost to expand storm-water surge capacity
	Enhanced Pond physical/chemical treatment, discharge	Low/Moderate (selenium, mercury)	Low/moderate - CCR and ELG rule[7]	$41		

Notes:
[1] Several configurations of biological treatment (and zero valent iron) were evaluated before GE ABMet was chosen as the selenium treatment option to evaluate against ZLD. Described further in **Appendix C**.
[2] Continuing to treat bottom ash water in ash ponds, with addition of chemical feed system to mitigate risk, would not achieve compliance with the CCR Rule as proposed due to requirement to close or line ponds. It also would not be expected achieve compliance with the ELG Rule as proposed due to a potential ban on bottom ash transport water discharge . NPV assumes pond-based with chemical feed in 2017 and then adding tank-based treatment three years later (a rough estimate of CCR compliance schedule, based on currently available information). Based on proposed ELG rule, compliance is anticipated in late 2017. Only relatively low capital cost is required for this compliance strategy, which allows IPL to, at a minimum, delay additional cost until more certainty exists around the outcome and timing of future regulations. Fly ash conversion to dry handling is scheduled to be done before the CCR rule requires closure or lining of ponds.

TABLE 7-1
Summary of Alternative Evaluation – Petersburg Generating Station

[3] The possibility of new limits if Outfall No. 001 relocated to White River were considered in assessing risk. Risks are assigned as: None (if wastewater stream is eliminated), Low, Moderate, or High likelihood of non-compliance with the Final limits in the current NPDES permits.
[4] NPV calculated as capital cost plus first 10 years of operating cost (future operation depreciated assuming 8.25% interest rate). Costs in this table do not sum to the total NPDES Compliance cost because there are costs outside of the defined wastewater g roups. Costs are shown for comparative purposes used in alternative evaluation.
[5] Some minor risk of final ELG putting "discharge" limits on the ZLD distillate if it used outside of the FGD system. If this o ccurs, operators will reuse the water in the FGD to avoid limits. Therefore, considered to be no risk.
[6] Based on proposed regulations.
[7] Compliance plan is for bottom ash seal water to flow to Other Water group. Because this water contains bottom ash, this may be determined to meet bottom ash transport water under the final ELGs and require modification to compliance strategy in the near future, in which case this seal trough water would instead be managed with Ash Water.
[8] NPDES project represents portion of fly ash project, so not able to calculate O&M costs as part of NPDES project

7.2.2 Compliance Strategy Evaluation for Final Limits - Ash Water – Fly Ash

The recommended compliance strategy for fly ash is conversion to dry fly ash handling. This is recommended based on the same evaluation process as described for Harding Street Station in **Section 6.** This includes modifying the existing dry fly ash system to help ensure system reliability and thereby prevent the need for wet ash sluicing as a backup to the dry ash system. Project costs include material upgrades for brine service associated with adding a pug mill ash unloader to each of the Unit 3 and Unit 4 ash silos, as well as replacing the ash fluidizing system on each ash silo to enhance the unloading system reliability.

7.2.3 Compliance Strategy Evaluation for Final Limits - Ash Water – Bottom Ash

The recommended compliance strategy for bottom ash is continued treatment in ash ponds, with addition of chemical feed and aeration to mitigate risk of non-compliance. This is recommended based on the same evaluation process as described for Harding Street Station in **Section 6**, though Petersburg has an additional consideration of cost to stabilize existing ponds if decide to continue treating in ponds. This will be the same chemical addition system described for the current limits (Section 7.2.1).

7.2.4 Compliance Strategy Evaluation for Final Limits - FGD Water

The recommended compliance strategy for FGD water is thermal ZLD with recycling. This is recommended based on the same evaluation process as described for Harding Street Station in **Section 6.** During the pilot test the ZLD option was refined by adding the recycle concept to reduce cost. This made ZLD cost-competitive with biological treatment, and hence it was chosen as the lower risk option. The results of the pilot test validated the sizing and cost estimate used for the biological treatment system during the project evaluation.

A pilot system of tank-based physical/chemical treatment followed by biological treatment (GE ABMet) was tested using Petersburg Station's FGD water. The results are discussed in **Section 4.3.7**.

7.2.5 Compliance Strategy Evaluation for Other Water

The recommended compliance strategy for Other Water group is tank-based physical/chemical treatment.

The recommended compliance strategy for the Other Water group of tank-based treatment was done using the same evaluation process as described for Harding Street in Section 6. An exception is that the Petersburg Station did not have the same concern as Harding Street Station around Harding Street's Unit 7 waste sump.

Early cost estimates (2012) showed pond-based treatment to be lower cost than tank-based, but as more information was obtained in 2013 through further geotechnical investigation of the ash pond and in 2014 through discussions with IDEM about the requirements for building a new pond within Pond A and closing the ponds, the cost estimate for the enhanced pond approach became higher than the tank-based treatment cost estimate. There is not room on the site to build the enhanced pond other than on retired ash ponds.

The "Other Water" group contains cooling tower blowdown, which is the source of total residual chlorine. As described in Section 3, there is a compliance risk with permit limits on TRC. The permit condition requires re-examining chlorination procedures, then evaluating the discharge. Therefore, IPL could proceed in a step-wise approach, and implement one or more changes, monitor, and then implement additional measure, if needed. For purposes of the cost estimate for the compliance strategy, it is assumed that treatment will be needed.

- Source Elimination – Operation of the chlorine dioxide addition system was evaluated in 2013. This evaluation revealed that the Unit 2 cooling tower received the same chlorine dioxide addition amount as the other cooling towers, even though it is approximately half the size. Therefore, the chlorine dioxide on this unit was reduced in September 2013, and IPL is monitoring the potential impacts of this change. Additional possible source reduction measure would include discontinuation of blowdown during the chlorine dioxide addition and for some time period after. This would allow the chlorine dioxide to be consumed or dissipate prior to blowing down to the ash pond.
- Effluent Treatment – Sodium bisulfite could be added to the ash pond effluent as it flows from Pond A to Pond A' through the T-pipes located between the ponds. Aeration could be used for mixing, and sodium bisulfite could be added directly to these pipes. Once cooling tower blowdown is routed to the Other Water group tank-based treatment system, the treatment can be done there. Additional treatability testing will be needed to determine chemical addition rates, design parameters, and treatment configuration. CH2M HILL has used their best professional judgment to forecast the cost of treatment.

7.2.6 Compliance Strategy Evaluation for Final Limits - Water Flowing to Outfall No. 007

The compliance strategy for the water flowing to Outfall No. 007 includes the following. The evaluation is described in **Appendix D**.

7.2.6.1 IUCS and Truck Wheel Wash

The IUCS pile is a source of boron above the discharge limit so it must be managed (eliminated, treated or reused). The recommended compliance strategy is <u>source elimination by covering the IUCS pile.</u> Covering the IUCS pile is preferred because it will reduce or eliminate tracking solids away from the pile that could become stormwater contaminants, and it will also help with meeting the general stormwater non-numeric requirements in permit Part I.D.4. Covering the pile will also eliminate the truck wheel wash.

7.2.6.2 Gypsum Pile Runoff

The recommended compliance strategy is source elimination by covering the outside gypsum pile. This will eliminate runoff from the outdoor gypsum pile. This will also help with meeting the general stormwater non-numeric requirements in permit Part I.D.4

7.2.6.3 Landfill Runoff

Mercury results in August and October 2013 were higher than previous results for Outfall No. 007 and represent a compliance risk for Outfall No. 007 limits. In late July and early August, the plant dug out a small section of the runoff ditch and repaired riprap and sediment control structures, which is anticipated with future maintenance work. This work may have stirred up sediments or solids and affected mercury results. Sulfate concentrations are greater than half the limit but have not exceeded the limit for the monitoring period. Therefore, there is a moderate risk that there may be future non-compliance with the NPDES permit based on historical erosion and associated run-off issues.

The current Poz-o-Tec cover has caused operational challenges as it has eroded in some locations, and plant operations must repair the cover.

The risk of non-compliance necessitates managing the runoff; therefore, the recommended option is covering the existing landfill Poz-o-Tec cover using soil and/or membrane. Covering is a lower-cost approach than managing the contaminated runoff. Using soil and/or membrane in new landfill areas rather than Poz-o-Tec will help avoid creating new contaminated stormwater and potentially minimize risk associated with future ELG and CCR rules. Several cover options exist, including clay-type soil and/or membrane or a chemical additive spray. The cover choice would need to be determined. An allowance is included in the NPDES compliance project cost estimate if a cover over the Poz-o-Tec proves to be necessary. The actual covering will be done under separate contract, not under the wastewater treatment system EPC contract.

SECTION 8

Recommended Compliance Strategy Plan

CH2M HILL recommended the selected compliance strategies based on choosing options that will minimize risk in a cost-efficient manner. This section summarizes the compliance strategies at each station, and includes a discussion of the cost and schedule for the recommended compliance strategies, as well as impacts on operations and permitting.

8.1 Recommended Compliance Strategy Plan - Harding Street Station

Compliance strategy options for the Harding Street Generating Station were screened based on feasibility, cost, and risks. It should be noted that this compliance plan assumes Harding Street Unit 7 continues to be coal-fired. An alternative compliance plan if Harding Street is converted to gas-fired is presented in Section 6.3. The recommended compliance strategy for Harding Street Unit 7 if coal-fired includes:

- **Wastewater**. The system includes:
  - A wastewater collection system of sumps, pumps, and pipes to transfer wastewater to the treatment systems including the onsite cinder pit and various stormwater detention ponds.
  - FGD wastewater treatment in a ZLD with recycle system.
  - Treatment of bottom ash sluice water in existing ponds, and add a chemical addition and aeration system.
  - Seal trough water (which carries small amounts of bottom ash) will continue to flow to Unit 7 waste sump, and from there along with other Unit 7 waste sump it will be pumped to the Other Water treatment system. (The system may be modified in the future to re-route this seal trough water to be managed with bottom ash water. This determination will be made once CCR and ELG rules are finalized.)
  - Elimination of fly ash transport water by converting to dry fly ash handling.
  - Treatment of “Other Water” stream (consisting of various “low-volume wastewater”, “cooling tower blowdown”, and “non-chemical metal cleaning wastewater” streams as defined in ELG) with tank-based physical/chemical treatment; and
  - Replacement of current demineralizer ion exchange beds and reverse osmosis (RO) system with a new reverse osmosis system with mixed-bed polishing and self-neutralization.
- **Stormwater**. In February 2013, ERM issued a report (i.e., stormwater Review Findings Report) that addressed compliance gaps associated with NPDES Permit Condition I.D. To ensure compliance with this permit condition, IPL plans to make modifications for the Harding Street facility as described in Section 2.
  - Street Sweeper purchase and use (such as to clean up fly ash off ground in loading area);
  - Unit 7 Bypass stack drain
  - Truck wheel wash
  - Unit 7 Precipitator Area Dust Control
  - Plant Paving and Drainage Improvements
  - Canopy for outdoor dumpster storage area

This CSP assumes that Harding Street Generating Station Units 3 and 4 are retired and Units 5 and 6 will be taken off-line or converted to natural gas before the 2017 compliance deadline of the Agreed Order. The design basis for this compliance strategy includes waste streams from Units 5 and 6 such as cooling tower blowdown, but not any CCR ash wastewaters.

8.2 Recommended Compliance Strategy Plan - Petersburg Station

Compliance strategy options for the Petersburg Generating Station were screened based on cost and risks. The recommended compliance strategy for Petersburg Units 1 through 4 includes:

- **Wastewater**. The system includes:
  - A wastewater collection system of sumps, pumps, and pipes to transfer wastewater to the treatment systems including the "red sea" and other various on-site stormwater detention ponds.
  - FGD wastewater treatment in a ZLD with recycle system.
  - Treatment of bottom ash sluice water in existing ponds, and add a chemical addition and aeration system.
  - Elimination of fly ash transport water by converting to dry fly ash handling.
  - Treatment of "Other Water" stream (consisting of various "low-volume wastewater" and "non-chemical metal cleaning wastewater" streams as defined in ELG) with tank-based physical/chemical treatment.
  - Compliance with permit limits for Outfall No. 007 will be accomplished using the following source control measures. These changes will also help ensure compliance with the NPDES permit's stormwater requirements:
    - Gypsum pile – a building will be constructed to cover this pile and prevent rainfall from contacting the material. This BMP will also meet stormwater non-numeric requirements of the NPDES permit.
    - IUCS material pile – a building will be constructed to cover this pile and prevent rainfall from contacting the material. This BMP will also meet stormwater non-numeric requirements of the NPDES permit.
    - Wheel wash stream – will be discontinued since covering the IUCS will help prevent the need for the wheel wash.
    - Landfill runoff – The cost of a cover over the Poz-o-Tec is included in the NPDES project cost estimate at this time.
- **Stormwater.** In December 2012, ERM issued a report (i.e., stormwater Review Findings Report) that addressed compliance gaps associated with NPDES Permit Condition I.D. To ensure compliance with this permit condition, IPL plans to make the following modifications for the facility in addition to the runoff-related changes described above (IUCS building, gypsum pile, landfill).
  - Improve dust suppression - River water supply fill station for Water Truck.
  - Street sweeper purchase and use (such as to clean up fly ash off ground in loading area).
  - Add miscellaneous road paving and sediment control structures such as silt fencing, straw bales, or erosion control matting.

8.3 Recommended Compliance Strategy Plan - Eagle Valley Generating Station

NPDES Permit No. IN0004693 issued to the Eagle Valley Generating Station on August 28, 2012, contains the effluent limits and/or monitoring requirements for ash pond effluent, once-through non-contact cooling water, oil water separator wastewater, and stormwater (Outfall No. 003); once through non-contact cooling water and stormwater (Outfall No. 002); and the internal ash pond discharge (Outfall 103). Stormwater limits, which include for the first time non-numeric effluent limitations, are also included in the permit. Because the coal-fired units at this facility are planned to be closed during the duration of the existing NPDES permit, no new requirements resulting from changes to water quality based limits or technology based limits are anticipated.

In December 2012, ERM issued a report (i.e., stormwater *Review Findings Report*) that addressed compliance gaps associated with NPDES Permit Condition I.D. These changes are planned to be done outside of the NPDES wastewater system EPC contract. To ensure compliance with this permit condition, IPL has committed to making the following modifications for the facility:

- When fly ash is removed from ponds and placed in trucks for transport, minimize fugitive emissions and ash spills: clean the loading area after each load or spill and do not load trucks when wind conditions are unfavorable.
- Update inspection forms for consistency with the information required for the routine inspections and comprehensive inspections.
- Clarify with IDEM the intent of Permit Condition No. I.D.4.j and request a permit modification.
- Revise and update the SWPPP.

8.4 Cost

The cost of the recommended wastewater compliance strategy is summarized in **Table 8-1**. Cost estimate detail is provided in **Tables 8-2** and **8-3**. IPL will contract most of the activities included in the projects in a single Engineer-Procure-Construct contract. The few items that will be required for compliance, but which IPL is planning to contract separately are identified in the two tables. This separate contracting is done for activities needed for NPDES compliance as well as to meet other requirements.

TABLE 8-1
Compliance Strategy Costs

	Cost Without Contingency See Tables 8-2 and 8-3 for Estimated Total Cost with Estimating Contingency		
Station	**Capital Costs[1] ($MM)**	**First Year O&M Costs[1] ($MM)**	**10-yr NPV[1] ($MM)**
Harding Street (Unit 7 coal-fired)	$125	$5.3	$160
Harding Street (Refueled to natural gas)[2]	$20	$0.6	$24
Petersburg	$158	$10.2	$225
Eagle Valley [3]	$0.03	$0.003	$0.04

Notes:

[1] Note that these costs are considered Class 4 estimates. Note that most, but not all, of the Capital cost will be in one Engineer Procure Construct (EPC) contract per plant. Some costs (such as dry fly ash handling, stormwater management, Harding Street water treatment upgrade affecting Unit 7 sump, Petersburg ash pond remediation, chemical feed/aeration systems, etc.) will be done under separate contract. Costs include in EPC project are delineated in Tables 8-2 and 8-3. Capital costs include equipment, installation, materials, and labor, construction costs, indirect costs, and startup/ commissioning costs. Capital costs do not include: modifying roads to treatment system, escalation if built for compliance later than 2017, initial set of shelf spares and spare parts, pond closure/post-closure costs (separate project), fly ash conversion at Petersburg (separate project), ash landfill construction, owner's costs, construction management, or allowance for funds used during construction (AFUDC).

Operations and maintenance (O&M) costs include operating labor, maintenance labor, maintenance materials, treatment chemicals, waste disposal, and power consumption.

[2] The HSS natural gas NPDES compliance strategy was based on the assumption that legacy ash pond wastewater would be discharged prior to September 30, 2017 and therefore, additional treatment would not be necessary. If it is determined that legacy ash pond wastewater cannot be discharged completely prior to the aforementioned date, treatment will need to be evaluated as part of the ash pond system closure process.

[3] Eagle Valley costs are IPL costs for a contractor to update inspection forms as part of the new SWPPP and do a site assessment of discharges, and a structural and non-structural stormwater control assessment.

8.4.1 Costing Approach

CH2M HILL developed costs based on values from a number of sources and site-specific factors. Costs were developed primarily using vendor quotations along with CH2M HILL cost estimating tools and experience on other similar projects. Vendor quotations were either specific to this project (such as the ZLD evaporator system) or based on cost curves of flow versus cost developed from vendor quotations. While these cost estimates are based on consideration of a number of site-specific factors, they are approximate. The project team screened technologies through a multi-stage process, with more precise cost estimates prepared in later stages as the compliance options were narrowed down. More detail on the selection process is provided in **Appendices B** and **C**.

The cost estimates shown have been prepared for guidance in comparing alternate treatment systems using information available at the time the estimates were prepared. The cost estimate for the options that were screened out in the first screening stage were developed using the methodology for a Class 5 estimate as defined by the Association for the Advancement of Cost Engineering International (AACEI, 2011). Typically, the accuracy range for a Class 5 estimate for the process industries is +100 percent/ -50 percent. CH2M HILL developed the cost estimates for those options passing through the first screening stage using the methodology for a Class 4 estimate as defined by AACEI including equipment factored or parametric models. Typically, the accuracy range for a Class 4 estimate for the process industries is +50 percent/ -30 percent. More accurate estimates will need to be prepared as the project scope becomes better defined. The final costs of the project and resulting feasibility will depend on actual labor and material costs, competitive market conditions, actual site conditions, final project scope, implementation schedule, continuity of personnel and engineering, and other variable factors. As a result, the final project costs will vary from the cost estimates presented herein. Because of this, project feasibility and funding needs must be carefully reviewed prior to making specific financial decisions to help ensure proper project evaluation and adequate funding.

The following should also be noted regarding this cost estimate:

- The purpose of this Estimate of Construction Cost is to establish an Engineer's opinion of probable construction cost at the 10 percent level of design development.
- This cost estimate has been prepared for guidance in project evaluation and implementation from the information available at the time of the estimate.
- This estimate includes Escalation with the assumption that the midpoint of construction being May 2016. CH2M HILL based this escalation forecast on economic data from Global Insight, Inc. and the United States Bureau of Labor Statistics.
- This cost estimate is considered a bottom rolled up type estimate with cost items and breakdown of Labor, Materials, and Equipment. Some quotations were obtained for various items. The estimate may include allowance cost and dollars per unit cost for certain components of the estimate.
- CH2M HILL has adjusted the estimate for local area labor rates, based upon 2013 union national average rates. Labor unit prices reflect a burdened rate, including: workers compensation, unemployment taxes, fringe benefits, and medical insurance.
- A 1.0 percent sales tax was added to all material costs within the estimate including process equipment.
- The estimate is based on the assumption the work will be done on a competitive bid basis and the contractor will have a reasonable amount of time to complete the work. All contractors are equal, with a reasonable project schedule, no overtime, constructed as under a single contract, no liquidated damages.
- Foundations for wastewater treatment system buildings and tanks will include auger cast piles.
- Cost of pond closure outside of the area at Petersburg where the wastewater treatment system will be built is not included.
- The net present value cost was estimated using an assumed annual interest rate of 8.25%.

The cost estimate excludes the following costs:

ATTACHMENT DHF-1
CAUSE NO. 44540

- Modifying roads to treatment system
- Escalation if built for compliance later than 2017
- Initial set of shelf spares and spare parts
- Pond closure/post-closure costs (separate project)

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Estimated Capital Cost

CLIENT: Indianapolis Power & Light Company (IPL
LOCATION: Harding Street Generating Station

Item	Value	Units	No. Provided	Equipment Unit Cost ($ ea)	Equipment Amount	Installation ($ ea)	Total Installed Cost ($)
FGD							
FGD Equalization Tank	321,000	gal	2				
Structural Wall	315	cu yd	2	118,133	236,267	118,133	436,385
Slab	133	cu yd	2	19,881	39,762	19,881	73,440
FGD Equalization Tank Agitator	30	HP	2	77,735	155,469	4,859	163,701
FGD Equalization Tank Treatment Feed Pump	380	gpm	4	19,378	77,511	4,357	84,893
FGD Recycle Reactor	5,000	gal	2	17,595	35,189	3,952	41,884
FGD Recycle Reactor Agitator	1	HP	2	41,706	83,412	1,763	86,399
FGD Recycle Clarifier	30	ft diameter	2	285,763	571,526	18,022	602,055
FGD Recycle Clarifier Sludge Pump	200	gpm	4	77,528	310,112	4,255	324,527
FGD Recycle Sludge Storage Tank	162,000	gal	1				
Structural Wall	228	cu yd	1	85,333	85,333	85,333	157,611
Slab	67	cu yd	1	10,000	10,000	10,000	18,470
FGD Recycle Sludge Tank Agitator	40	HP	1	82,762	82,762	5,927	87,781
FGD Recycle Storage Tank	167,000	gal	1				
Structural Wall	243	cu yd	1	91,067	91,067	91,067	168,200
Slab	69	cu yd	1	10,340	10,340	10,340	19,098
FGD Recycle Pump	550	gpm	2	26,169	52,337	4,885	60,613
FGD Softening Reactor	2,000	gal	2	8,333	16,667	1,667	19,490
FGD Softening Reactor Agitator	1	HP	2	41,706	83,412	1,763	86,399
FGD Softening Clarifier	20	ft diameter	2	221,401	442,802	14,532	467,419
FGD Softening Clarifier Sludge Pump	100	gpm	4	48,504	194,016	4,083	207,849
Softening Sludge Storage Tank	162,000	gal	1				
Structural Wall	228	cu yd	1	85,333	85,333	85,333	157,611
Slab	67	cu yd	1	10,000	10,000	10,000	18,470
Softening Sludge Tank Agitator	40	HP	1	82,762	82,762	5,927	87,781
Evaporator Feed Tank	72,000	gal	2	47,500	95,000	9,500	111,093
Evaporator Feed Tank Agitator	10	HP	2	51,180	102361	2,724	106,976
Evaporator Feed Pump	118	gpm	2	8,912	17,824	3,872	24,384
Antiscale Metering Pump	0.0	gph	3	12,000	36,000	3,784	45,615
Antifoam Metering Pump	0.03	gph	3	12,000	36,000	3,784	45,615
ZLD Evaporator Package			1		7,486,685	3,743,343	10,657,297
Softener Feed Heat Exchanger	46	gpm	2	--	--	--	--
	18,697	BTU/min					
Evaporator Feed Second Stage Heat Exchanger	59	gpm	2	--	--	--	--
	9,840	BTU/min					
Evaporator Deaerator	59	gpm	2	--	--	--	--
Evaporator Deaerator Vacuum Pump							
Evaporator	59	gpm	2	--	--	--	--
Distillate (each)	54	gpm					
Blowdown (each)	4.2	gpm					
Evaporator Seed Recirculation Pump	1,215	gpm	3	--	--	--	--
Evaporator Vapor Compressor	400	HP	2	--	--	--	--
Evaporator Desuperheater			2	--	--	--	--
Evaporator Mist Eliminator			2	--	--	--	--
Hot Distillate Tank	19,401	gal	2	--	--	--	--
Hot Distillate Pump	108	gpm	2	--	--	--	--
Desuperheater Water Supply Pump	10.0	gpm	2	--	--	--	--
Hydrocyclone	5.3	gpm	2	--	--	--	--
Evaporator Seed Tank	11	gal	2	--	--	--	--
Structural Wall	1.0	cu yd					
Slab	0.1	cu yd					
Evaporator Seed Tank Agitator	1.0	HP	2	--	--	--	--
Evaporator Seed Recycle Pump	0.5	gpm	3	--	--	--	--
Distillate and Brine Disposal							
Cold Distillate Tank	22,000	gal	2	57,157	114,314	17,793	144,456
Distillate Transfer Pump	110	gpm	2	8,592	17,185	3,864	23,730
Brine Cooler	4	gpm	2	9,534	19,069		19,069
	3,103	BTU/min					
Brine Tank	23,000	gal	2	59,484	118,969	18,607	150,490
Brine Tank Agitator	5.0	HP	2	45,917	91,834	2,190	95,544
Brine Pump	100.0	gpm	2	8,586	17,171	4,787	25,280
Fly Ash Pug Mill	2	tons/min	2	47,094	94,188	9,419	110,144
Ash Flow							
Dry Fly Ash System (Fly Ash Silo, Transfer Station & Piping, Blowers) (c)			1	6,300,000	6,300,000	5,000,000	10,535,000

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Estimated Capital Cost

CLIENT: Indianapolis Power & Light Company (IPL
LOCATION: Harding Street Generating Station

Item	Value	Units	No. Provided	Equipment Unit Cost ($ ea)	Equipment Amount	Installation ($ ea)	Total Installed Cost ($)
CT BD + Misc.							
Other Wastewater Equalization Tank	546,000	gal	2				
Structural Wall	430	cu yd	2	161,333	322,667	161,333	595,965
Slab	225	cu yd	2	33,800	67,600	33,800	124,857
Other Wastewater Equalization Tank Agitator	30	HP	4	77,735	310,938	4,859	327,401
Other Wastewater Equalization Tank Pump	2,000	gpm	4	84,090	336,361	16,198	391,240
Other Wastewater Mix Tank	21,000	gal	2	44,177	88,355	8,835	88,531
Other Wastewater Mix Tank Agitator	2.0	HP	2	42,759	85,518	1,870	88,686
Other Wastewater Effluent Blower	10.0	HP	2	2,329	4,658	466	5,447
Mix Tank Diffuser System	2.5	scfm	80	55	4,400		4,400
Other Wastewater Clarifier	90	ft diameter	2	671,935	1,343,870	29,916	1,394,547
Other Wastewater Clarifier Sludge Pump	300	gpm	4	106,552	426,208	4,427	441,206
Other Wastewater Effluent Tank	5,000	gal	1	18,675	18,675	3,735	18,712
Organosulfide Metering Pump	2	gph	3	12,000	36,000	1,400	39,557
Ferric Chloride Tank	6,000	gal	1	37,600	37,600	5,720	42,445
Ferric Chloride Metering Pump	5	gph	3	12,000	36,000	1,400	39,557
Caustic Storage Tank	14,000	gal	1	80,800	80,800	12,760	91,608
Caustic Metering Pump	90	gph	5	12,000	60,000	1,400	65,929
WWTP Service Water Pump	1,000	gpm	2	19,219	38,438	6,427	49,325
Other Wastewater Effluent Pump	300	gpm	2	8,921	17,841	4,498	25,461
Common Equipment							
Lime Silo	73	tons ea	1	342,769	342,769	6,800	348,528
Lime Recirculation Pump	240	gpm	2	--	--	--	--
Lime Slurry Tank	200	gal	2	--	--	--	--
Lime Slurry Tank Agitator	1	HP	2	--	--	--	--
Swing Sludge Storage Tank	162,000	gal	1				
Structural Wall	228	cu yd	1	85,333	85,333	85,333	157,611
Slab	67	cu yd	1	10,000	10,000	10,000	18,470
Swing Sludge Tank Agitator	40	HP	1	82,762	82,762	5,927	87,781
Sludge Pit	25,000	gal	1				
Structural Wall	30	cu yd	1	11,111	11,111	11,111	20,522
Slab	25	cu yd	1	3,733	3,733	3,733	6,895
Sludge Pit Agitator	5	HP	1	45,917	45,917	2,190	47,772
Sludge Pit Pump	15	HP	2	4,797	9,595	3,791	16,017
Filter Press	500	cf	2	1,875,000	3,750,000	43,905	3,824,374
Filter Press Feed Pump	75	HP	4	48,000	192,000	4,768	208,153
Polymer Metering Pump	56	gph	6	12,000	72,000	1,400	79,115
Polymer Blending System	1	gph	2	25,000	50,000	1,700	52,880
Area Labor Adjustment Factor	84.7%	applies to installation cost only			25,274,000		
Total Equipment Cost (TEC)							**25,274,000**
Total Construction Material					27,534,000		
Freight	4%	of Proc Equip					1,011,000
State Sales Tax	1.0%	of Material					528,000
Purchased Equipment Cost - Delivered (PEC-D							**26,813,000**
WWTP Building, (floor area, 2 stories)	25,000	ft²				$250.00	6,250,000
Site work Allowance							700,000
Auger Cast Pile	142200	linear feet				$110.00	15,642,000
Geogrid Layer for WWTP Roads	110385	ft²				$0.40	44,000
Installation Costs							8,894,000
Pipe Rack (part of fly ash conversion activities) (c)							4,894,000
Piping	15%	of PEC-D					4,022,000
Instrumentation and Controls	12%	of PEC-D					3,218,000
Electrical	25%	of PEC-D					6,703,000
Electrical Power Transmission Feed	Allowance	of PEC-D					1,056,000
Electrical Building, XFMR, swtchgr MCC	Allowance	of PEC-D					1,500,000
Yard Improvements (a)	3%	of PEC-D					804,000
Metals and Finishes	5%	of PEC-D					1,341,000
Subtotal							81,881,000
Total Direct Costs (TDC)							**81,881,000**
Contractor's Field General Conditions	5%	of TDC					4,094,000
Contractor's OH&P	12%	of TDC					9,826,000
Escalation Factor	12%	of TDC					9,465,000
Subtotal Indirects and Escalation							**23,385,000**
Subtotal Construction, Indirects, and Escalation							**105,266,000**
EPC - Engineering and Procurement	10%						10,527,000
EPC - Construction Permits & Testing	2%						2,105,000
EPC - Startup	3%						3,158,000
Copper and Iron Treatment		Total Installed Cost					525,000
Subtotal EPC - Engineering, Startup, Permitting and Testing							**16,315,000**

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Estimated Capital Cost

CLIENT: Indianapolis Power & Light Company (IPL
LOCATION: Harding Street Generating Station

Item	Value	Units	No. Provided	Equipment Unit Cost ($ ea)	Equipment Amount	Installation ($ ea)	Total Installed Cost ($)
					High Range +50%	Base Bid	Low Range -30%
Total Construction - Fly Ash EPC and Wastewater EPC Cost (TCC) without Estimating Contingency (b) (f)					182,372,000	**121,581,000**	85,107,000
Total Construction - Fly Ash EPC and Wastewater EPC Cost (TCC) with Estimating Contingency (b) (f)	20%			16,376,000	206,936,000	**137,957,000**	96,570,000
Other Project Related Costs							
Engineering Design of Ash Pond 4 Subgrade	1	LS				450,000	450,000
Ash Pond Closure Planning & Design	1	LS				300,000	300,000
Stormwater Activities (c)		Total Installed Cost					695,000
Demin Replacement System (c)		Total Installed Cost					1,500,000
Subtotal Project Related Costs							**2,945,000**
					High Range +50%	Base Bid	Low Range -30%
Total Estimated Order of Magnitude Capital Cost with Other Project Costs but without Estimating Contingency (d) (e) (f)					186,789,000	**124,526,000**	87,168,000
Total Estimated Order of Magnitude Capital Cost with Estimating Contingency and Other Project Costs (d) (e) (f)					211,353,000	**140,902,000**	98,631,000

(a) Includes fencing, grading, roads, sidewalks, and similar items.
(b) The enclosed Engineer's Estimate is only an estimate of possible construction costs. This estimate is limited to the conditions existing at its issuance and is not a guarantee of actual price or cost. Uncertain market conditions such as, but not limited to: local labor or contractor availability, wages, other work, material market fluctuations, price escalations, force majeure events, and developing bidding conditions etc may affect the accuracy of this estimate. CH2M Hill is not responsible for any variance from this estimate or actual prices and conditions obtained.
(c) Not included in the EPC project.

(d) Cost estimate is considered a Class IV estimate (per Association for the Advancement of Cost Engineering International definition) with accuracy of +50/-30%.
(e) Does not include Owner's Costs

(f) Estimating Contingency: (1) An amount added to an estimate to allow for items, conditions, or events for which the state, occurrence, or effect is uncertain and that experience shows will likely result, in aggregate, in additional costs. Typically estimated using statistical analysis or judgment based on past asset or project experience. Contingency usually excludes 1) Major scope changes such as changes in end product specification, capacities, building sizes, and location of the asset or project; 2) Extraordinary events such as major strikes and natural disasters; 3) Management reserves; and 4) Escalation and currency effects. Some of the items, conditions, or events for which the state, occurrence, and/or effect is uncertain include, but are not limited to, planning and estimating errors and omissions, minor price fluctuations (other than general escalation), design developments and changes within the scope, and variations in market and environmental conditions. Contingency is generally included in most estimates, and is expected to be expended

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Annual O&M Cost

CLIENT: Indianapolis Power & Light Company (IPL)
LOCATION: Harding Street Generating Station

Item	Quantity	Units	Unit Cost	Cost
Labor	24,960	hours	$ 30	$ 748,800
Maintenance (% of Purchased Equipment Cost)	26,813,000	$	3%	$ 804,390
FGD				
Energy	6,100	MW-Hr	$ 100	$ 610,000
Chemicals				
Antiscalant	175	gallons	$ 14.18	$ 2,476
Antifoam	186	gallons	$ 14.18	$ 2,639
Polymer	92	gallons	$ 7.96	$ 732
Lime	2,662	tons	$ 272.80	$ 726,054
Waste Solids Disposal	24,500	tons	$ 32.00	$ 784,000
Incremental Fly Ash Management Costs*		tons	$ -	$ 543,815
Ash Flow				
Energy	70	MW-Hr	$ 100	$ 7,000
Chemicals				
Lime	13	tons	$ 272.80	$ 3,410
Organosulfide	9,658	gallons	$ 20.00	$ 193,158
Polymer	5,595	gallons	$ 7.96	$ 44,536
Maintenance (% of Purchased Equipment Cost)	98,000	$	3%	$ 2,940
CT BD + Misc.				
Energy	2,300	MW-Hr	$ 100	$ 230,000
Chemicals				
Ferric Chloride	33,628	gallons	$ 1.66	$ 55,663
Sodium Hydroxide	21,979	gallons	$ 1.10	$ 24,177
Organosulfide	14,249	gallons	$ 20.00	$ 284,982
Polymer	3,363	gallons	$ 7.96	$ 26,770
Common Equipment				
Energy	1,900	MW-Hr	$ 100	$ 190,000
Total Annual O&M				**$ 5,286,000**
NPV (rounded) - without contingency				**$ 160,000,000**
NPV (rounded) - with contingency				**$ 176,000,000**

*Increase in annual cost due to changes in wastewater management from current practices

Assumptions:

Rate of return, i =	**8.25%**	
Period =	**10 years**	**(max 25 yrs)**
Total Installed Cost (without contingency)=	$124,526,000	
Total Installed Cost (with contingency)=	$140,902,000	
Annual O&M Estimate =	$5,286,000	

Factor to account for the plant not operating at full capacity 70%

CH2MHILL

Estimated Capital Cost

CLIENT: Indianapolis Power & Light Company (IPL)
LOCATION: Petersbug Generating Station

Item	Value	Units	No. Provided	Equipment Unit Cost ($ ea)	Equipment Amount	Installation ($ ea)	Total Installed Cost ($)
FGD							
Dewatering Storage Tank	432,000	gal	2	333,754	667,507	66,751	780,583
Dewatering Storage Tank Agitator	25	HP	4	72,471	289,884	4,325	304,539
Dewatering Storage Pumping (from existing thicke	500	gpm	2	24,171	48,343	4,713	56,326
FGD Equalization Tank	1,093,000	gal	2				
Structural Wall	569	cu yd	2	213,333	426,667	213,333	788,053
Slab	451	cu yd	2	67,600	135,200	67,600	249,714
FGD Equalization Tank Agitator	30	HP	8	77,735	621,876	4,859	654,802
Treatment Feed Pump	700	gpm	3	32,161	96,482	5,490	110,431
FGD Recycle Reactor	8,000	gal	2	24,576	49,153	6,394	59,985
FGD Recycle Reactor Agitator	2	HP	2	42,759	85,518	1,870	88,686
FGD Recycle Clarifier	35	ft diameter	2	317,944	635,888	19,605	669,099
FGD Recycle Clarifier Sludge Pump	400	gpm	4	135,576	542,304	4,599	557,884
FGD Recycle Sludge Storage Tank	162,000	gal	1				
Structural Wall	228	cu yd	1	85,333	85,333	85,333	157,611
Slab	67	cu yd	1	10,000	10,000	10,000	18,470
FGD Recycle Sludge Tank Agitator	40	HP	1	82,762	82,762	5,927	87,781
FGD Recycle Storage Tank	1,624,000	gal	1				
Structural Wall	704	cu yd	1	264,000	264,000	264,000	487,608
Slab	670	cu yd	1	100,533	100,533	100,533	185,685
FGD Recycle Pump	800	gpm	2	36,155	72,310	5,966	82,416
FGD Softening Reactor	8,000	gal	2	24,758	49,517	4,952	57,905
FGD Softening Reactor Agitator	2	HP	2	42,759	85,518	1,870	88,686
FGD Softening Clarifier	40	ft diameter	2	350,125	700,250	21,081	735,961
FGD Softening Clarifier Sludge Pump	300	gpm	4	106,552	426,208	4,427	441,206
Filtrate Surge Tank	212,000	gal	1	176,876	176,876	35,375	206,839
Softening Sludge Storage Tank	162,000	gal	1				
Structural Wall	228	cu yd	1	85,333	85,333	85,333	157,611
Slab	67	cu yd	1	10,000	10,000	10,000	18,470
Softening Sludge Tank Agitator	40	HP	1	82,762	82,762	5,927	87,781
Evaporator Feed Tank	12,000	gal	2	33,037	66,075	6,607	77,268
Evaporator Feed Tank Agitator	3	HP	2	43,811	87623	1,977	90,972
Evaporator Feed Pump	300	gpm	2	16,182	32,364	4,167	39,423
Antiscale Metering Pump	0.1	gph	3	12,000	36,000	3,784	45,615
Antifoam Metering Pump	0.1	gph	3	12,000	36,000	3,784	45,615
#5 Ball Mill Tank	276,000	gal	1	648,266	648,266	224,600	838,502
ZLD Evaporator Package			1		12,103,866	6,051,933	17,229,854
Softener Feed Heat Exchanger	268	gpm	2	--	--	--	--
	79,717	BTU/min					
Evaporator Feed Second Stage Heat Exchanger	150	gpm	2	--	--	--	--
	41,688	BTU/min					
Evaporator Deaerator	150	gpm	2	--	--	--	--
Evaporator Deaerator Vacuum Pump							
Evaporator	150	gpm	2	--	--	--	--
Distillate (each)	145	gpm					
Blowdown (each)	2.1	gpm					
Evaporator Seed Recirculation Pump	5,429	gpm	3	--	--	--	--
Evaporator Vapor Compressor	1,000	HP	2	--	--	--	--
Evaporator Desuperheater			2	--	--	--	--
Evaporator Mist Eliminator			2	--	--	--	--
Hot Distillate Tank	1,311	gal	2	--	--	--	--
Hot Distillate Pump	289	gpm	2	--	--	--	--
Desuperheater Water Supply Pump	6.0	gpm	2	--	--	--	--
Hydrocyclone	2.7	gpm	2	--	--	--	--
Evaporator Seed Tank	5	gal	2	--	--	--	--
Structural Wall	0.8	cu yd					
Slab	0.1	cu yd					
Evaporator Seed Tank Agitator	1.0	HP	2	--	--	--	--
Evaporator Seed Recycle Pump	0.3	gpm	3	--	--	--	--
Distillate and Brine Disposal							
Cold Distillate Tank	183,000	gal	1	431,836	431,836	148,879	557,937
Distillate Transfer Pump	290	gpm	2	15,783	31,565	4,146	38,588
Brine Coolers	4	gpm	2	8,610	17,220		17,220
	2,618	BTU/min					
Brine Tank	29,000	gal	2	73,448	146,895	23,493	186,691
Brine Tank Agitator	7.5	HP	2	48,549	97,097	2,457	101,260

CH2MHILL

Estimated Capital Cost

CLIENT: Indianapolis Power & Light Company (IPL)
LOCATION: Petersbug Generating Station

Item	Value	Units	No. Provided	Equipment Unit Cost ($ ea)	Equipment Amount	Installation ($ ea)	Total Installed Cost ($)
Brine Pump	100.0	gpm	2	8,586	17,171	4,787	25,280
CT BD + Misc.							
Other Wastewater Equalization Tank	546,000	gal	2				
Structural Wall	430	cu yd	2	161,333	322,667	161,333	595,965
Slab	225	cu yd	2	33,800	67,600	33,800	124,857
Other Wastewater Equalization Tank Agitator	30	HP	4	77,735	310,938	4,859	327,401
Other Wastewater Equalization Tank Pump	3,667	gpm	8	80,000	640,000	44,265	939,941
Other Wastewater Mix Tank	59,000	gal	3	82,107	246,320	16,421	288,047
Other Wastewater Mix Tank Agitator	8	HP	3	48,549	145,646	2,457	151,890
Other Wastewater Effluent Blower	19	HP	2	2,329	4,658	466	5,447
Mix Tank Diffuser System	2.5	scfm	200	55	11,000		11,000
Other Wastewater Clarifier	125	ft diameter	3	897,202	2,691,606	29,693	2,767,057
Other Wastewater Clarifier Sludge Pump	200	gpm	6	77,528	465,168	4,255	486,791
Other Wastewater Effluent Tank	32,000	gal	1	56,880	56,880	11,376	66,515
Ferric Chloride Tank	9,000	gal	1	53,800	53,800	8,360	60,881
Ferric Chloride Metering Pump	21	gph	4	12,000	48,000	1,400	52,743
Caustic Tank	14,000	gal	1	80,800	80,800	12,760	91,608
Caustic Metering Pump	48	gph	6	12,000	72,000	1,400	79,115
Organosulfide Metering Pump	9	gph	4	12,000	48,000	1,400	52,743
WWTP Service Water Pump	1,000	gpm	2	19,219	38,438	6,427	49,325
Other Wastewater Effluent Pump	11,000	gpm	2	166,339	332,678	41,585	403,123
Common Equipment							
Lime Silo	151	tons ea	1	494,007	494,007	6,800	499,767
Lime Recirculation Pump	240	gpm	2	--	--	--	--
Lime Slurry Tank	200	gal	2	--	--	--	--
Lime Slurry Tank Agitator	1	HP	2	--	--	--	--
Swing Sludge Storage Tank	162,000	gal	1				
Structural Wall	228	cu yd	1	85,333	85,333	85,333	157,611
Slab	67	cu yd	1	10,000	10,000	10,000	18,470
Swing Sludge Tank Agitator	40	HP	1	82,762	82,762	5,927	87,781
Sludge Pit	25,000	gal	1				
Structural Wall	30	cu yd	1	11,111	11,111	11,111	20,522
Slab	25	cu yd	1	3,733	3,733	3,733	6,895
Sludge Pit Agitator	5	HP	1	45,917	45,917	2,190	47,772
Sludge Pit Pump	15	HP	2	80,000	160,000	3,517	165,957
Filter Press	500	cf	3	1,875,000	6,625,000	43,905	6,736,561
Filter Press Feed Pump	75	HP	6	48,000	288,000	4,768	312,230
Polymer Blending System	2	gph	2	25,000	50,000	1,700	52,880

Area Labor Adjustment Factor	84.7%	applies to installation cost only	33,074,000		
Total Equipment Cost (TEC)					**33,074,000**
Total Construction Material			30,982,000		
Freight	4%	of Proc Equip			1,323,000
State Sales Tax	1.0%	of Material			641,000
Purchased Equipment Cost - Delivered (PEC-D)					**35,038,000**
WWTP Building, (floor area, 2 stories)	25,000	ft^2		$250.00	6,250,000
Covering of IUCS Area	24,975	ft^2		$134.00	3,347,000
Site work Allowance					900,000
Auger Cast Pile - 18 inch diameter, 3785 ACPs, 45 LF each for all WWTP structures with 25 ft casing	170,325	linear feet		$110.00	18,736,000
Geogrid Layer for WWTP Roads	75,490	ft^2		$0.40	30,000
Installation Costs					8,015,000
Piping	15%	of PEC-D			5,256,000
Instrumentation and Controls	12%	of PEC-D			4,205,000
Electrical	25%	of PEC-D			8,760,000
Electrical Power Transmission Feed	Allowance	of PEC-D			1,056,000
Electrical Building, XFMR, swtchgr MCC	Allowance	of PEC-D			1,500,000
Yard Improvements (a)	3%	of PEC-D			1,051,000
Ash Pond - Initial Excavation/Surface Stabilization (18 acres, 9 feet deep)	0	cu yd		$20.00	0
Mix-In 5% Lime for Stabilization	0	cu yd		$170.00	0
Initial Dewatering, Drying, and Surface Stabilization	2	acres		$50,000.00	100,000

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Estimated Capital Cost

CLIENT: Indianapolis Power & Light Company (IPL)
LOCATION: Petersbug Generating Station

Item	Value	Units	No. Provided	Equipment Unit Cost ($ ea)	Equipment Amount	Installation ($ ea)	Total Installed Cost ($)
Industrial Baffle Wall - HDPE Sheetpiling, 2,175 ft long, 25 ft, H-pile lateral support driven 35 feet	10,875	ft^2				$55.00	598,000
Enhanced Pond Liner, Materials, and Liner Surface Preparation (+/-18 acres)	0	ft^2				$4.00	0
Geogrid Layer At Enhanced Pond Berm Bottom	0	ft^2				$0.41	0
Additional Fill Material Between WWTP and Enhanced Pond (5 AC) - 5 ft Deep	0	cu yd				$31.00	0
Pond Closure Gravel Cover System	164,300	ft^2					310,000
Pond Closure Asphalt Cover System	24,600	ft^2				$4.00	98,000
Metals and Finishes	5%	of PEC-D					1,752,000
Subtotal							97,002,000
Total Direct Costs (TDC)							**97,002,000**
Contractor's Field General Conditions	5%	of TDC					4,850,000
Contractor's OH&P	12%	of TDC					11,640,000
Escalation Factor	12%	of TDC					11,213,000
Subtotal Indirects and Escalation							**27,703,000**
Subtotal Construction, Indirects and Escalation							**124,705,000**
EPC - Engineering and Procurement	10%						12,471,000
EPC - Construction Permits & Testing	2%						2,494,000
EPC - Startup	3%						3,741,000
Total Residual Chlorine and Iron Treatment (e)		Total Installed Cost					831,000
Subtotal EPC - Engineering, Startup, Permitting and Testing							**19,537,000**
					High Range +50%	**Base Bid**	**Low Range -30%**
Total Construction - EPC Cost (TCC) without Estimating Contingency (b) (h)					216,363,000	**144,242,000**	100,969,000
Total Construction - EPC Cost (TCC) <u>with</u> Estimating Contingency (b) (h)	20%		19,400,000		245,463,000	**163,642,000**	114,549,000
Other Project Related Costs							
Unit Thickener tank rehab (c)							1,267,500
Covering of Landfill (c) (d)	32	acres				$70,000	3,802,000
Covering of Gypsum Pile (c)	13,800	ft^2				$134.00	3,125,000
SCS to improve stability of Ponds B and C (c)	1	LS				700,000	700,000
Ash Pond Closure Planning and Design (c)	1	LS				200,000	200,000
Dry Fly Ash Handling System Upgrades (c)		Total Installed Cost					2,350,000
Stormwater Activities (c)		Total Installed Cost					2,050,000
Subtotal Project Related Costs							**13,494,500**
					High Range +50%	**Base Bid**	**Low Range -30%**
Total Estimated Order of Magnitude Capital Cost with Other Project Costs but <u>without</u> Estimating Contingency (f) (g) (h)					236,605,000	**157,736,500**	110,416,000
Total Estimated Order of Magnitude Capital Cost with Estimating Contingency and Other Project Costs (f) (g) (h)					265,705,000	**177,136,500**	123,996,000

(a) Includes fencing, grading, roads, sidewalks, and similar items.
(b) The enclosed Engineer's Estimate is only an estimate of possible construction costs. This estimate is limited to the conditions existing at its issuance and is not a guarantee of actual price or cost. Uncertain market conditions such as, but not limited to: local labor or contractor availability, wages, other work, material market fluctuations, price escalations, force majeure events, and developing bidding conditions etc may affect the accuracy of this estimate. CH2M Hill is not responsible for any variance from this estimate or actual prices and conditions obtained.
(c) Items not included in wastewater treatment plant EPC project.

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Estimated Capital Cost

CLIENT: Indianapolis Power & Light Company (IPL)
LOCATION: Petersbug Generating Station

Item	Value	Units	No. Provided	Equipment Unit Cost ($ ea)	Equipment Amount	Installation ($ ea)	Total Installed Cost ($)

(d) Landfill covering will be done if additional sampling proves cover is needed for compliance with NPDES permit.
(e) IPL is evaluating options for TRC compliance. Costs range from $200,000 to $458,000. IPL will choose approach once testing completed in early 2014 and cost estimate will be updated.
(f) Cost estimate is considered a Class IV estimate (per Association for the Advancement of Cost Engineering International definition) with accuracy of +50/-30%.
(g) Does not include Owner's Costs
(h) Estimating Contingency: (1) An amount added to an estimate to allow for items, conditions, or events for which the state, occurrence, or effect is uncertain and that experience shows will likely result, in aggregate, in additional costs. Typically estimated using statistical analysis or judgment based on past asset or project experience. Contingency usually excludes: 1) Major scope changes such as changes in end product specification, capacities, building sizes, and location of the asset or project; 2) Extraordinary events such as major strikes and natural disasters; 3) Management reserves; and 4) Escalation and currency effects. Some of the items, conditions, or events for which the state, occurrence, and/or effect is uncertain include, but are not limited to, planning and estimating errors and omissions, minor price fluctuations (other than general escalation), design developments and changes within the scope, and variations in market and environmental conditions. Contingency is generally included in most estimates, and is expected to be expended

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Annual O&M Cost

CLIENT: Indianapolis Power & Light Company (IPL)
LOCATION: Petersburg Generating Station

Item	Quantity	Units	Unit Cost	Cost
Labor	24,960	hours	$ 30	$ 749,000
Maintenance (% of Purchased Equipment Cost)	35,038,000	$	3%	$ 1,051,000
FGD				
Energy	19,600	MW-Hr	$ 100	$ 1,960,000
Chemicals				
Antiscalant	719	gallons	$ 14.18	$ 10,000
Antifoam	767	gallons	$ 14.18	$ 11,000
Polymer	144	gallons	$ 7.96	$ 1,000
Lime	5,522	tons	$ 272.80	$ 1,506,000
Waste Solids Disposal	60,200	tons	$ 32.00	$ 1,926,000
Incremental Fly Ash Management Costs*		tons	$ -	$ -
Ash Flow				
Energy	80	MW-Hr	$ 100	$ 8,000
Chemicals				
Lime	13	tons	$ 272.80	$ 3,000
Polymer	10,709	gallons	$ 7.96	$ 85,000
Sodium Bisulfite	1,123,778	lb	$ 0.56	$ 629,000
Maintenance (% of Purchased Equipment Cost)	151,000	$	3%	$ 5,000
CT BD + Misc.				
Energy	5,500	MW-Hr	$ 100	$ 550,000
Chemicals				
Ferric Chloride	125,773	gallons	$ 1.66	$ 208,000
Sodium Hydroxide	98,414	gallons	$ 1.10	$ 108,000
Organosulfide	53,294	gallons	$ 20.00	$ 1,066,000
Polymer	12,577	gallons	$ 7.96	$ 100,000
Common Equipment				
Energy	1,900	MW-Hr	$ 100	$ 190,000
Total Annual O&M				**$ 10,166,000**
NPV (rounded) - without contingency				**$ 225,000,000**
NPV (rounded) - with contingency				**$ 245,000,000**

*Increase in annual cost due to changes in wastewater management from current practices

Assumptions:

Rate of return, i = **8.25%**
Period = **10 years** **(max 25 yrs)**
Total Installed Cost (without contingency) = $157,736,500
Total Installed Cost (with contingency) = $177,136,500
Annual O&M Estimate = $10,166,000

Factor to account for the plant not operating at full capacity 70%

8.5 Preliminary Compliance Schedule

The AOs for Case Nos. 2013-21497-W and 2013-21498-W, for the Petersburg and Harding Street Generating Stations, respectively, were approved by IDEM on April 29, 2013. These AOs contain compliance schedule milestones for meeting the WQBELs established in NPDES Permit Nos. IN0002887 and IN0004685. The AOs modify the schedules for compliance that were established in these NPDES permits, which originally required final compliance to be achieved within 36 months from the permit effective date of October 1, 2012. The AO established schedule for meeting compliance for both facilities is summarized in **Table 8-4**. Written certification deadlines are also shown.

A schedule detailing the design and construction phases will be a requirement of the EPC contractor. A preliminary estimate of project cost over time is provided in **Figure 8-2**.

TABLE 8-4
Compliance Schedule for Meeting Water Quality Based Effluent Limits (WQBELs) under AOs for Case Nos. 2013-21497-W and 2013-21498-W for the Petersburg and Harding Street Generating Stations

Activity	AO Deadline	AO Certification Deadline
1. Complete Pilot Testing	March 7, 2014	March 14, 2014[1]
2. Select Compliance Strategy[4]	July 1, 2014	July 8, 2014
3. Complete Procurement of EPC Contractor	September 26, 2014	October 3, 2014[1]
4. Complete Design of Treatment System(s) and Procurement of Long-Lead Time Equipment/Units	September 18, 2015	September 25, 2015[2]
5. Commence Construction and Remaining Procurement of Equipment/Units	September 19, 2015	September 26, 2015[2]
6. Complete Construction and Construction-Related Testing	June 2, 2017	June 9, 2017[1] July 2, 2017[3]
7. Complete Startup and Commissioning	September 29, 2017	October 6, 2017[1]

Notes:

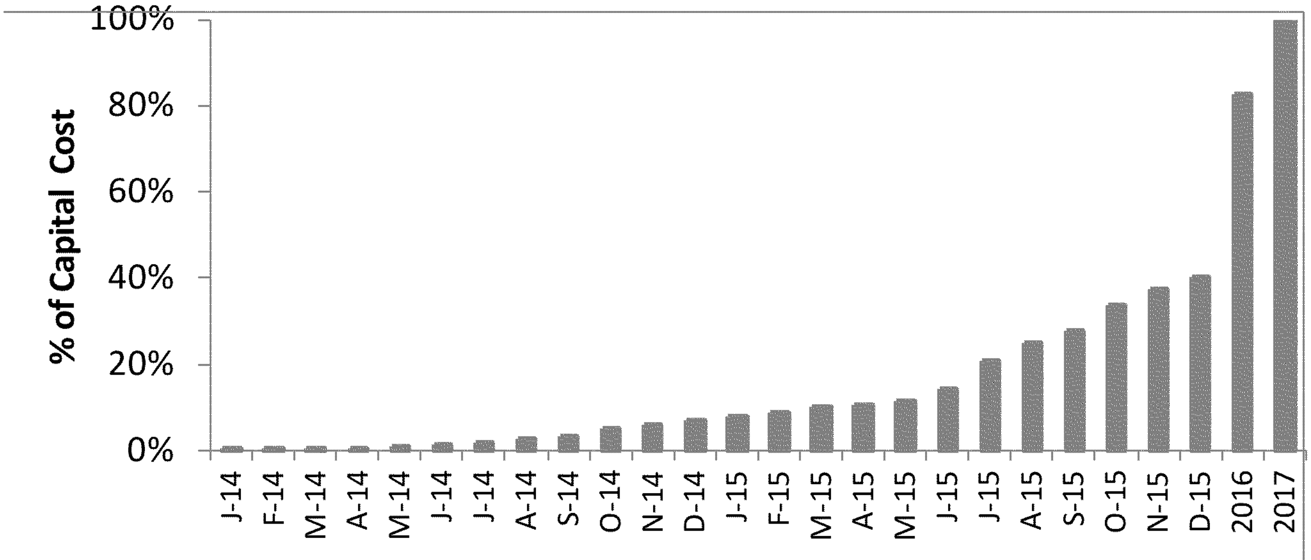
[1] Written certification is required by this date or 7 calendar days after the date the activity is completed, whichever is earlier.

[2] One written certification for both activities may be submitted; refer to item 2.b of Part II of the AO for the deadline of this submission

[3] Within 30 days of completion of construction, a notice of installation for the additional pollutant control equipment and any modifications along with a design summary as applicable must be submitted to the Industrial NPDES Permits Section and Enforcement Section of IDEM, Office of Water Quality.

[4] On January 22, 2014 IDEM approved modifying the AO schedule for the "Select Compliance Strategy" milestone from March 7 to July 1, 2014.

FIGURE 8-2
Cost Projection Estimate



8.6 Potential Operational and Compliance Issues

This section describes operational and compliance issues including staffing and monitoring.

8.6.1 Staffing

The proposed CSP will require increased staffing at each station. CH2M HILL's current estimate is 12 full-time operations staff at each station – Harding Street and Petersburg. CH2M HILL developed this estimate based on assuming: one supervisor, two operators all of the time (one at control room and one roaming) which requires 10 full-time staff to have two people present at all times, plus one person operating the wastewater treatment system filter press during the day. Each station will also need roughly two full-time equivalent maintenance staff for the wastewater system, primarily for mechanical and electrical maintenance, as well as instrumentation and controls. Support will also be needed from plant chemist staff (¼ to ½ FTE) and onsite laboratory staff (½ FTE). The cost for these maintenance staff is included in the Maintenance line item of the estimate of annual cost.

8.6.2 Permitting

IPL will need to obtain appropriate permits from the federal, state, and local level for the changes associated with these compliance activities.

8.6.3 Monitoring

8.6.3.1 Compliance Monitoring

Compliance with effluent limitations is evaluated via sampling and analysis of the wastewater effluent. The frequency of sampling for each pollutant parameter is established in the permit based on the permitting authority's BPJ. Factors that the permit writer may consider when establishing a monitoring frequency are: 1) the type of treatment process and retention time, 2) the environmental significance and nature of the pollutant, 3) the cost of monitoring relative to the discharger's capabilities and benefit obtained, 4) the facility compliance history, 5) the number of monthly samples used in developing the permit limit, and 6) the effluent variability.[2] IDEM has applied a monitoring frequency of twice per month for most conventional and toxic pollutants in the permits issued to the IPL Harding Street and Petersburg facilities, with frequencies for some parameters as often as daily (for flow, temperature, and chlorination/bromination dose, frequency, and duration) or as infrequently as six times per year for non-stormwater outfalls.

[2] The Environmental Protection Agency Technical Support Document for Water Quality-Based Toxics Control. March 1991. Page 113.

Sample types (e.g., grab, composite) are also established in the permit based on the pollutant parameter, type of waste stream, and the permitting authority's BPJ. Sampling for constituents that are affected by compositing techniques, including pH, cyanide, total phenols, O&G, sulfide, chlorine, temperature, e-coli, and volatile organic compounds, must always be collected as grab samples. Sampling of intermittent discharges and stormwater is also required via grab sampling methods. Other factors that the permit writer may consider when establishing the sample type for each pollutant are the variability of the wastewater characteristics, if instantaneous or average concentrations are needed, and if a measure of the mass loading per unit of time is needed. When composite samples are required, composite sampling techniques defined in IPL's permits require the collection of a minimum of three flow-proportioned grab samples or using a programmable automated composite sampler that collects aliquots over evenly spaced intervals in a specified period of time (e.g., 8 hours, 24 hours) and combines them into a composite sample. EPA has established approved methods for wastewater analysis in 40 CFR Part 136. Analysis of wastewater samples for NPDES permit compliance must be performed using an EPA-approved method found in 40 CFR Part 136 that is sufficiently sensitive to determine compliance with the applicable limit or water quality criterion. IDEM may also specify test methods and detection or quantitation limits for pollutant analysis. If effluent limits are established that are lower than the limit of quantitation for a particular pollutant parameter, compliance is demonstrated if the effluent concentrations measured are less than the limit of quantitation.

EPA is reinforcing this requirement in proposed revisions to the steam electric generating ELG, in the third "anti-circumvention" provision which states, *"Last, the anti-circumvention provisions would expressly require permittees to use analytical EPA-approved methods that are sufficiently sensitive to provide reliable quantified results at levels necessary to demonstrate compliance with the effluent limits proposed by this rulemaking when such methods are available. ....For purposes of the proposed anti-circumvention provision, a method is ''sufficiently sensitive'' when the sample-specific quantitation level for the wastewater being analyzed is at or below the level of the effluent limitation."*

8.6.3.2 Process Monitoring

It should be noted that 'real time' treatment process monitoring for many of the regulated parameters is not feasible because there are no in-line instruments proven for use in industrial water chemistry matrices. This is true of the metals potentially regulated by the proposed steam electric generating ELG BAT limits on FGD water (arsenic, selenium, and mercury) and many of the trace metals in the NDPES permit. Field measurements for nitrates have known interferences. This requires less direct approaches to control treatment processes and ensure they are meeting discharge limits, such as onsite colorimetric tests run with spectrophotometers, sample reagent chemicals (such as from Hach Corporation,) or other surrogate measurements. IPL can use field analytical methods for process control, but such methods are not useful for monitoring to show compliance.

8.7 Factors that Might Drive Future Refinement to the Compliance Strategy Plan

The main goal of the wastewater compliance team was to recommend a compliance strategy to meet effluent limitations included in the Harding Street and Petersburg Generating Stations NPDES permits. The requirements of these permits are defined; however, other additional limits or requirements may be added in future permit cycles. Additional requirements may also result from future potential regulations. The wastewater compliance team has worked to develop a compliance strategy with a low risk of non-compliance and adaptability to potential future environmental regulations at the lowest reasonable cost. IPL will continue to monitor regulatory activity and update compliance strategy recommendations in the event that the regulatory outlook changes and additional information becomes available.

Factors that may drive future refinement of this compliance strategy plan include potential future steam electric generating ELG rule revision, 316(a) thermal variance study results, future 316(b) regulation, and future CCR regulation. These factors were described in Section 5. Most notably, the project team anticipates that there is a high probability that the final CCR rule may prohibit the continued use of unlined ash ponds. This would necessitate a future change to the bottom ash compliance strategy to tank-based treatment. If the final version of these regulations differs than what has been anticipated, it may necessitate additional changes in this wastewater CSP.

IPL and CH2M HILL submitted data and comments on the proposed steam electric generating ELG rule to support the EPA's selection of certain, less-stringent requirements; however, the final rule is not currently anticipated to be issued until the end of September 2015.

An evaluation of the preliminary NPDES compliance strategy against the proposed ELG's requirements are shown in **Table 8-5**.

TABLE 8-5
Initial Assessment of Steam Electric Generating ELG Requirements Compared to Compliance Strategy

FGD[1]	Fly Ash	Bottom Ash[2]	Combustion Residual Leachate[3]	Flue Gas Mercury Control	Non-Chemical Metal Cleaning[4]
Zero liquid discharge using evaporator	Dry Handling	Continue to treat in existing ash pond and discharge, with chemical addition and aeration	Leachate is not collected at landfill or surface impoundments (SI's). However, landfill runoff may be regulated under the ELG. This would be an existing source – so subject to BPT.	Dry Handling	Clarifier

Notes:

Green = compliance with proposed ELG

Yellow = Some risk of issues with ELG, based on the proposed ELG. Need final ELG to verify.

[1] Some minor risk of final ELG putting "discharge" limits on the ZLD distillate if it used outside of the FGD system. If this occurs, operators will reuse the water in the FGD to avoid limits.

[2] Moderate risk that final ELG will ban discharge of bottom ash water

[3] It is anticipated that these limits will not apply unless landfill stormwater is exposed with coal combustion material of landfill and reaches outfall and/or ash pond seepage reaches waters of the United States.

[4] Some risk because EPA's definition of NCMC is not clear. NCMC limits are currently contained in NPDES permits; therefore no ELG impact.

SECTION 9

References

Indiana Department of Environmental Management (IDEM). April 29, 2013. Agreed Order for Case No. 2013-21497-W. State of Indiana County of Marion Commissioner of the Department of Environmental Management v. Indianapolis Power & Light Company – Petersburg Generating Station.

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GE. August 2012.Water Management Study (Mid-Project Review Presentation).

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U.S. Environmental Protection Agency (EPA). June 21, 2010. 40 CFR Parts 257, 261, 264 et. al. Hazardous and Solid Waste Management System; Identification and Listing of Special Wastes; Disposal of Coal Combustion Residuals from Electric Utilities; Proposed Rule. Federal Register Volume 75, No. 118, pages 35128-35264.

Appendix A
Petersburg Outfall Relocation
Estimated Permit Limits

TECHNICAL MEMORANDUM

CH2MHILL®

Petersburg – Outfall Relocation Estimated Permit Limits

PREPARED FOR: Nysa Hogue
David Harter
David Kehres

PREPARED BY: CH2MHILL

DATE: July 1, 2013
Updated December 19, 2013

PROJECT NUMBER: 472525

Executive Summary

CH2M HILL has estimated potential permit limits for relocation of Indianapolis Power and Light Company's (IPL's) Petersburg Station's Outfalls 001 and 007 to the White River. These calculations were submitted to the Indiana Department of Environmental Management (IDEM) for informal review to ensure the calculation methodology is consistent with state regulations.

The Environmental Protection Agency (EPA) Region 5 and IDEM have not approved the estimated permit limits and any related relaxation of permit limits associated with relocation of outfall(s) to the White River pursuant to Section 402(o) of the Clean Water Act with regard to antibacksliding provisions. This presents a moderate-high risk for this compliance option evaluation.

For scenarios which include fly and bottom ash transport water, effluent data was used to evaluate projected effluent concentrations. In some cases, this was limited to 6 months of NPDES monitoring data. For scenarios without ash handling water, the three samples collected as part of the GE study were used, and CH2M HILL combined the individual wastewater streams (i.e., flue gas desulfurization [FGD], Bottom Ash, and Other Water) to estimate the discharge quality. The analysis assumes the compliance point for water quality limits will be at the point where all wastewaters are combined post-treatment, if they are combined. The limited data presents a moderate risk for this compliance option evaluation.

This potential compliance option evaluation detailed information including treatment, risks and costs is included in the "Compliance Strategy Plan", the Petersburg "Outfall 007 Compliance Options Evaluation", and the Petersburg "Effluent Metals Wastewater Treatment Study - Overall Approach and Design Basis".

Future Boron Limits

The results of this analysis suggest that if FGD water is discharged and the bottom ash water is not discharged there is a high risk of potential boron limits at the Station's outfall to the White River.

Sulfate

The results of this analysis indicate that there would be no sulfate limit for discharge of Outfall 007 to the White River. However, there is limited data available, and there was lower rainfall than typical during the data collection period. Higher rainfall has historically led to more landfill runoff which results in the need for more maintenance activities, resulting in higher concentrations of sulfate and other constituents. Therefore, there is some risk that there would be a sulfate limit at the White River, depending on the collection of additional data.

Introduction

CH2M HILL prepared a Technical Memorandum (TM), *Indianapolis Power & Light NPDES Permit Limits Evaluation – Petersburg Generating Station*, dated April 22, 2013, which was submitted to the Indiana Department of Environmental Management (IDEM). The TM to IDEM documented CH2M HILL's calculations for estimated permit limits for relocation of Indianapolis Power and Light Company's (IPL's) Outfalls 001 and 007 to the White River. The IDEM TM presented potential estimated limits which were based on water-quality and/or technology based effluent limitations (water quality based effluent limits [WQBELs] or technology based effluent limits [TBELs]). TBELs were based on the current Effluent Limitation Guidelines for the Steam Electric Power Generating Point Source Category (40 CFR 423). This TM presents the results of the evaluation for potential estimated limits based on the following six scenarios:

1. Discharge of Outfalls 001 and 007 separately to White River (includes bottom ash (BA) and fly ash (FA))
2. Discharge of Outfalls 001 and 007 separately to White River without Ash Transport Water (neither BA or FA)
3. Combined Discharge of Outfalls 001 and 007 to White River (includes BA and FA)
4. Combined Discharge of Outfalls 001 and 007 to White River without Ash Transport Water (neither BA or FA)
5. Discharge of Outfalls 001 and 007 separately to White River without Fly Ash Transport Water (includes BA)
6. Combined Discharge of Outfalls 001 and 007 to White River without Fly Ash Transport Water (includes BA)

WQBELS were calculated in accordance with the procedures in 327 IAC 5-2-11.4 and 327 IAC 5-2-11.6. The procedure takes into account the effluent flow, receiving stream flow, acute and chronic criteria, and the concentrations of pollutants in the receiving stream. The WQBEL for boron is driven by the acute water quality criterion of 41,000 µg/L and the resulting WQBEL of 47,330 µg/L is the same for all scenarios. This is an updated WQBEL for boron that was provided by IDEM in July 2013.

The projected effluent quality calculated for each scenario is based on wastewater sampling data. Monthly discharge monitoring reports (DMRs) data for Outfall Nos. 001 and 007 were used for scenarios that include ash handling water. For scenarios that do not include fly ash and/or bottom ash handling water, effluent quality was estimating using a flow-weighted average for the contributing wastewater streams based on 3 samples collected by GE between October 2011 and May 2012. For these scenarios, the soluble concentrations were used to represent the metals concentration that would be expected after treatment of the wastewater in a pond, since solids will be removed in the pond. Because the effluent quality was calculated for these scenarios, a formal RPE analysis cannot be completed and, as such, the effluent quality is compared to one-half of the permit limits to determine the risk for a permit limit.

Scenario 1

Scenario 1 includes relocation of Outfall No. 001 and Outfall No. 007 separately to the White River, and includes ash handling (both BA and FA) waters (current operating scenario without MATS impact). It is not likely that both outfalls would be routed in separate pipes to the White River. However, IDEM requested this scenario.

Outfall 001

The results of the reasonable potential to exceed (RPE) evaluation for cadmium, copper, iron, mercury, selenium, zinc, and boron are presented in Table 1 for Scenario 1. Table A-1 in Appendix A-1 is a complete table of results for the RPE for Outfall 001 discharging to White River. This evaluation indicates that several metals have a potential to exceed the estimated WQBELs, including copper, mercury and zinc.

Table 2 presents the estimated TBELs and a comparison of the effluent data to half of the TBEL limit.

TABLE 1
Partial Results of Reasonable Potential to Exceed Statistical Procedure
Scenario 1 – Discharge of Outfall 001 to White River with Ash Transport Water (both BA and FA)
IPL Petersburg Generating Station, Pike County

Parameter	Monthly Average Comparison			Daily Maximum Comparison			Reasonable Potential to Exceed?
	Monthly Average PEQ[1] (µg/L)	Monthly Average WQBEL[2] (µg/L)	PEQ > WQBEL?	Daily Maximum PEQ[1] (µg/L)	Daily Maximum WQBEL[2] (µg/L)	PEQ > WQBEL?	
Cadmium	12.0	12.0	No	10.0	21.0	No	No
Copper	48.0	46.0	Yes	66.0	79.0	No	Yes
Iron	1,936	3,168	No	3,000	5,488	No	No
Mercury	0.588	0.012	Yes	0.588	0.020	Yes	Yes
Selenium	132	150	No	140	260	No	No
Zinc	384	279	Yes	528	483	Yes	Yes
Boron	22,550	47,330	No	25,300	82,000	No	No

1. PEQ = Projected Effluent Quality determined by procedures in 327 IAC 5-2-11.5

2. WQBELs based on the 2-year Maximum Monthly Average flow (2011-2012) for Outfall 001 of 19.8 cfs (12.8 MGD) as set forth by 327 IAC 5-2-11.4(a)(9)

TABLE 2
Comparison of Estimated Effluent Concentrations and TBELs
Scenario 1 – Discharge of Outfall 001 to White River with Ash Transport Water (both BA and FA)
IPL Petersburg Generating Station, Pike County

Parameter	Monthly Average Comparison			Daily Maximum Comparison			Estimated Effluent Conc. > ½ TBEL
	Maximum Monthly Average Effluent Conc[1] (µg/L)	Monthly Average TBEL[2] (µg/L)	Estimated Effluent Conc > ½ TBEL?	Maximum Daily Maximum Conc[1] (µg/L)	Daily Maximum TBEL[2] (µg/L)	Estimated Effluent Conc. > ½ TBEL?	
TSS	15,640	29,883	Yes	68,000	99,610	Yes	Yes
O&G	2,721	11,629	No	8,000	15,505	Yes	Yes
FAC	50.4	199	No	110	498	No	No
Chromium	5.28	177	No	11.0	177	No	No
Copper	17.0	360	No	60.0	360	No	No
Iron	499	995	Yes	2,000	995	Yes	Yes
Zinc	107	875	No	480	875	Yes	Yes

1. Data are based on effluent concentrations for Outfall 001 as reported on the DMR reports during the January 2009 through September 2013 period of record.
2. Calculated from the applicable effluent guidelines in 40 CFR Part 423 using the combined wastestream formula (CWF).

Outfall 007

The results of the RPE for cadmium, mercury, selenium, and boron are presented in Table 3 for Outfall 007 for Scenario 1. Table A-2 in Appendix A-1 contains complete results for the RPE for Outfall 007 discharging to White River. Table 4 presents the estimated TBELs for Outfall 007 for Scenario 1. The evaluation indicates there is a reasonable potential to exceed the water quality based effluent limit for cadmium and mercury. Outfall 007 includes runoff from the landfill, a calcium sulfite/ash waste pile and a truck wheel wash. The landfill covers an area of approximately 50 acres, which can generate a high volume of runoff depending on the storm event.

TABLE 3
Partial Results of Reasonable Potential to Exceed Statistical Procedure

Scenario 1 – Discharge of Outfall 007 to White River
IPL Petersburg Generating Station, Pike County

Parameter	Monthly Average Comparison			Daily Maximum Comparison			Reasonable Potential to Exceed?
	Monthly Average PEQ[1] (µg/L)	Monthly Average WQBEL[2] (µg/L)	PEQ > WQBEL?	Daily Maximum PEQ[1] (µg/L)	Daily Maximum WQBEL[2] (µg/L)	PEQ > WQBEL?	
Cadmium	13.0	11.0	Yes	11.0	20.0	No	Yes
Mercury	0.134	0.012	Yes	0.134	0.020	Yes	Yes
Selenium	32.5	150	No	27.5	260	No	No
Boron	13,130	47,330	No	12,100	82,000	No	No

1. PEQ = Projected Effluent Quality determined by procedures in 327 IAC 5-2-11.5
2. WQBELs based on the 2-year Maximum Monthly Average flow (2011-2012) for Outfall 007 of 0.37 cfs (0.24 MGD) as set forth by 327 IAC 5-2-11.4(a)(9)

TABLE 4
Comparison of Estimated Effluent Concentrations and TBELs
Scenario 1 – Discharge of Outfall 007 to White River
IPL Petersburg Generating Station, Pike County

Parameter	Monthly Average Comparison			Daily Maximum Comparison			Estimated Effluent Conc. > ½ TBEL
	Maximum Monthly Average Conc.[1] (µg/L)	Monthly Average TBEL[2] (µg/L)	Estimated Effluent Conc. > ½ TBEL?	Maximum Daily Maximum Conc[1] (µg/L)	Daily Maximum TBEL[2] (µg/L)	Estimated Effluent Conc. > ½ TBEL?	
TSS	11,045	30,000	No	32,000	100,000	No	No
Oil & Grease	2,724	15,000	No	8,100	20,000	No	No

1. Data are based on effluent concentrations for Outfall 007 as reported on the DMR reports during the January 2009 through September 2013 period of record.
2. Calculated from the applicable effluent guidelines in 40 CFR Part 423 using the combined wastestream formula (CWF).

IPL has sampled the landfill runoff separately, and an evaluation of the alternative options for management of Outfall No. 007 wastewater streams is provided in the *Indianapolis Power & Light Company -Petersburg Outfall No. 007 Options Evaluation* Technical Memorandum dated October 17, 2013.

Scenario 2

Scenario 2 is the relocation of Outfalls 001 and 007 separately to the White River without ash handling (neither BA or FA) water post wastewater treatment. Outfall 007 does not contain ash handling water and so the evaluation of 007 is the same as presented for Scenario 1. Table 5 presents the estimated effluent concentrations compared to the calculated WQBELs for selenium, boron and mercury for Outfall 001. A complete table of results is presented in Table A-3 in Appendix A-1. Mercury concentrations exceed half of the estimated effluent concentration for the monthly average limit and the daily maximum.

Table 6 presents the estimated technology based effluent limits (TBELs) and a comparison of the effluent data to half of the TBEL limit.

TABLE 5
Partial Results of Preliminary Effluent Limits Comparison
Scenario 2 – Discharge of Outfall 001 to White River without Ash Transport Water (neither BA or FA)
IPL Petersburg Generating Station, Pike County

Parameter	Monthly Average Comparison			Daily Maximum Comparison			Greater than ½ Limit?
	Average Estimated Effluent Conc. (µg/L)	Monthly Average WQBEL [1] (µg/L)	Estimated Effluent Conc. >½ Limit?	Maximum Estimated Effluent Conc. (µg/L)	Daily Maximum WQBEL[1] (µg/L)	Estimated Effluent Conc. >½ Limit?	
Mercury	1.025	0.012	Yes	1.511	0.020	Yes	Yes
Selenium	35.4	150	No	69.8	260	No	No
Boron	21,875	47,330	No	22,574	82,000	No	No

1. WQBELs based on the estimated flow for Outfall 001 without Ash Transport Water of 9.7 cfs (6.3 MGD).

TABLE 6
Comparison of Estimated Effluent Concentrations to the TBELs
Scenario 2 – Discharge of Outfall 001 to White River without Ash Transport Water (neither BA or FA)
IPL Petersburg Generating Station, Pike County

Parameter	Monthly Average Comparison			Daily Maximum Comparison			Estimated Effluent Conc. > 1/2 TBEL?
	Average Estimated Effluent Conc.[1] (µg/L)	Monthly Average TBEL[2] (µg/L)	Estimated Effluent Conc. >½ TBEL?	Maximum Estimated Effluent Conc.[1] (µg/L)	Daily Maximum TBEL[2] (µg/L)	Estimated Effluent Conc. >½ TBEL?	
TSS	30,000	29,665	Yes	30,000	98,883	No	Yes
O&G	4,710	5,348	Yes	6,688	7,130	Yes	Yes
FAC	--	--	ND	--	--	ND	ND
Chromium	55.7	187	No	67.3	187	No	No
Copper	16.1	60	No	26.5	60	No	No
Iron	11,578	984	Yes	18,887	984	Yes	Yes
Zinc	7.79	970	No	0.47	970	No	No

1. Estimated effluent concentrations are based on samples collected by GE between October 2011 and May 2012 from the wastewater streams that contribute to the ash pond.
2. Calculated from the applicable effluent guidelines in 40 CFR Part 423 using the combined wastestream formula (CWF).
ND = No Data

As shown in Table 5, the monthly average boron concentration for Outfall 001 is slightly less than half of the estimated monthly average water quality based effluent limit with ash transport water. Boron data are being collected currently on Outfall Nos. 001 and Outfall 007. The monthly average and daily maximum boron concentrations for Outfall 001 are presented in Figures 1 and 2, respectively. Table B-1 and B-2 in Appendix A-2 contain the boron monitoring results for Outfalls 001 and 007, respectively. There is one Outfall 001 result of 23,000 µg/L which is close to half of the estimated monthly average limit of 47,330 µg/L. Removing all ash transport water, including the bottom ash transport water stream, will increase the boron effluent concentration, as well as the concentration of other constituents.

Figures 1 and 2 show that boron data demonstrates compliance with the expected average monthly and daily maximum limitations. However, concentrations are at half of the monthly average limit. Therefore removing bottom ash flow, which contains relatively low boron concentrations will likely increase estimated effluent concentrations above half of the permit limit.

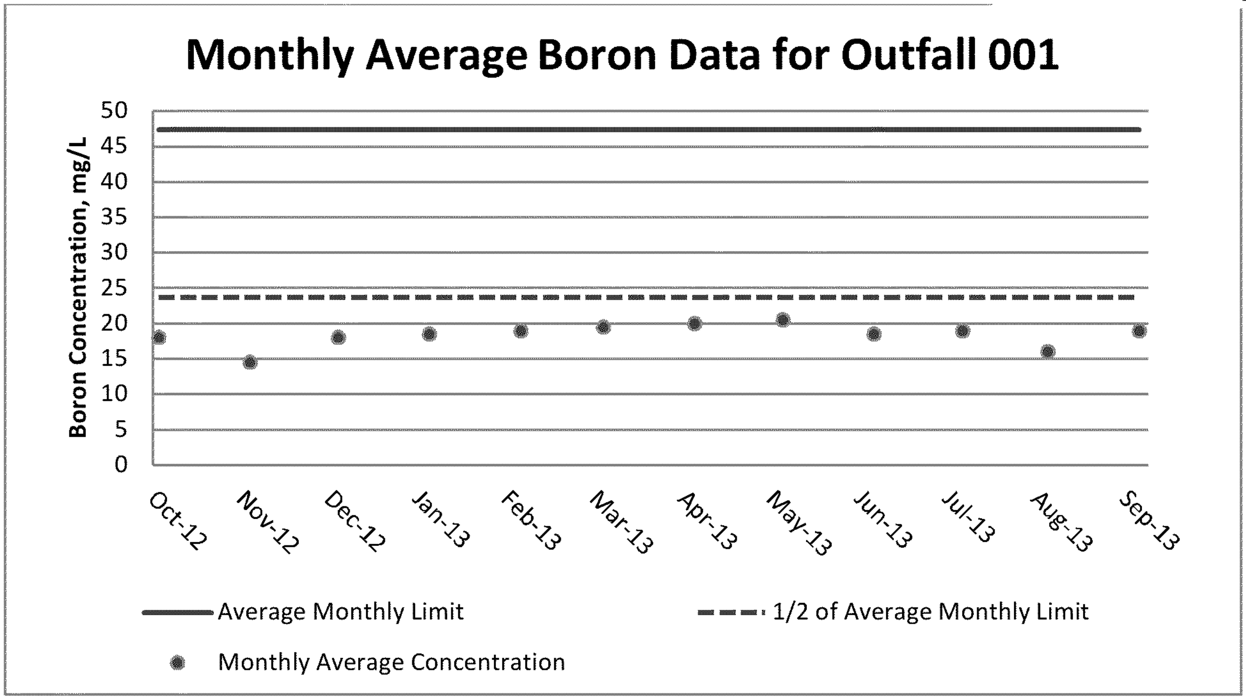


FIGURE 1
Outfall 001 Monthly Average Boron Data
IPL Petersburg Generating Station, Pike County

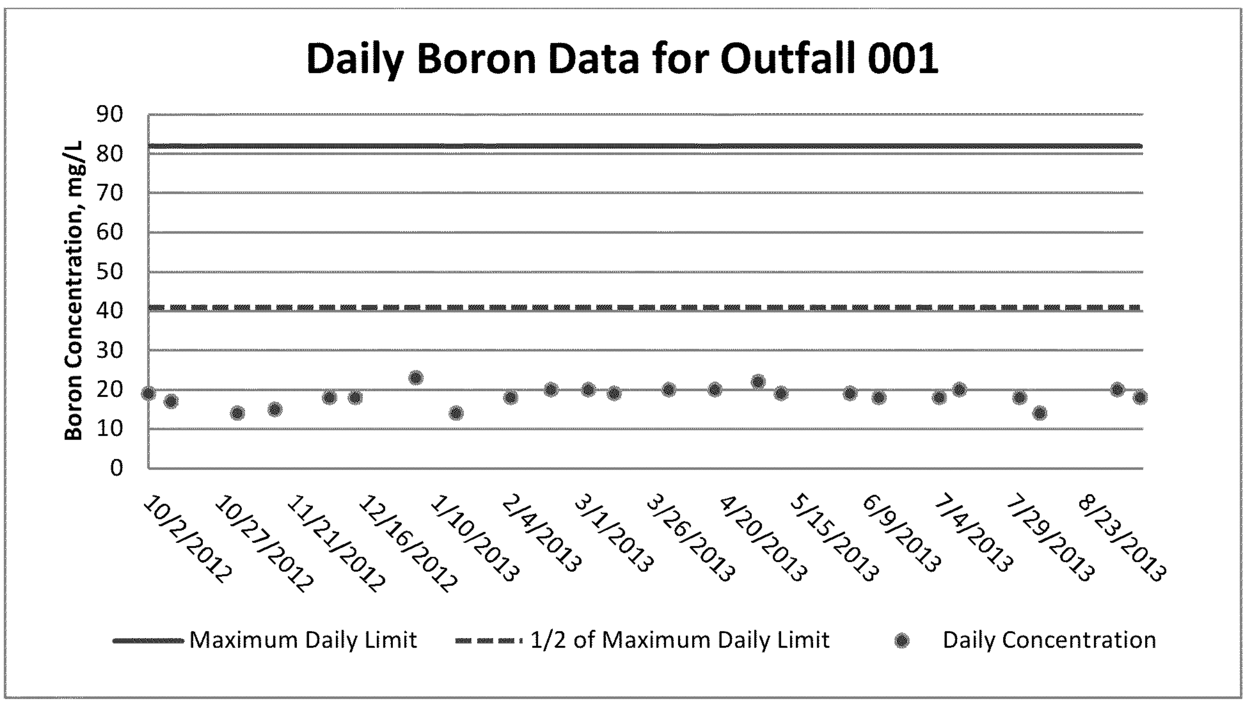


FIGURE 2
Outfall 001 Daily Boron Data
IPL Petersburg Generating Station, Pike County

A mass balance approach was taken to further evaluate boron concentrations without ash transport water. The average and maximum boron concentrations from the three GE sample results were used to estimate the boron contributions from each wastewater stream, as presented in Table 7. The total ash transport wastestreams contribute about 30-40% of the boron and 66% of the flow. Based on this determination, the concentrations of boron were estimated for Outfall 001 after the removal of this wastestream. The resulting estimated boron concentrations are provided in Table 8. The estimated concentrations that exceed the calculated monthly average boron water quality based effluent limit of 47,330 µg/L (47.3 mg/L) are highlighted. This is considered a moderate-high risk for compliance with future boron limits.

TABLE 7
Boron Mass Balance for Wastewater Streams Contributing to Outfall 001
Scenario 2 – Discharge of Outfall 001 to White River without Ash Transport Water (neither BA or FA)
IPL Petersburg Generating Station, Pike County

Wastewater Stream	Average Boron (mg/L)	% of Total	Maximum Boron (mg/L)	% of Total	Flow (gpm)	Flow (MGD)	Flow - % of Total
Other	1.96	4%	2.8	4%	3,509	5	28%
Total Ash	7	30%	12	40%	8,338	12	66%
FGD	200	66%	208	56%	647	1	5%
Combined	**15**	**100%**	**19**	**100%**	**12,714**	**18**	**100%**

TABLE 8
Estimated Boron Concentrations at Outfall 001 after Removal of Ash Transport Water
Scenario 2 – Discharge of Outfall 001 to White River without Ash Transport Water (neither BA or FA)
IPL Petersburg Generating Station, Pike County

Date	Flow (MGD)	001 Boron (mg/L)	Estimated Boron without Ash Handling Water – Using Maximum Boron Concentrations (mg/L)	Estimated Boron without Ash Handling Water – Using Average Boron Concentrations (mg/L)
10/2/2012	11.01	19	41	44
10/10/2012	9.61	17	36	40
11/2/2012	13.26	14	30	33
11/15/2012	10.85	15	32	35
12/4/2012	12.96	18	39	42
12/13/2012	9.08	18	39	42
1/3/2013	10.15	23	**49**	**54**
1/17/2013	13.67	14	30	33
2/5/2013	12.45	18	39	42
2/19/2013	11.01	20	43	47
3/4/2013	11.48	20	43	47
3/13/2013	8.93	19	41	44
4/1/2013	11.92	20	43	47
4/17/2013	14.85	20	43	47
5/2/2013	10.89	22	47	**51**
5/10/2013	9.62	19	41	44
6/3/2013	12.12	19	41	44
6/13/2013	12.98	18	39	42
7/4/2013	15.11	18	39	42
7/11/2013	11.05	20	43	47
8/1/2013	7.26	18	39	42
8/8/2013	15.33	14	30	33
9/4/2013	11.01	20	43	47
9/12/2013	11.96	18	39	42

Scenario 3

Scenario 3 is the combined discharge of Outfalls 001 and 007 to White River with fly ash and bottom ash handling water. Table 9 presents a partial list of the estimated WQBELs compared to the projected effluent quality. A complete list of parameters is located in Table A-4 of Appendix A-1. Pollutant parameters that are likely to require a WQBELs include copper, mercury, and zinc. Table 10 presents the estimated technology based effluent limits (TBELs) and a comparison of the effluent data to half of the TBEL limit for Scenario 3.

TABLE 9
Partial Results of Reasonable Potential to Exceed Statistical Procedure
Scenario 3 – Combined Discharge of Outfalls 001 and 007 to White River with Ash Transport Water (both BA and FA)
IPL Petersburg Generating Station, Pike County

Parameter	Monthly Average Comparison			Daily Maximum Comparison			Reasonable Potential to Exceed?
	Monthly Average PEQ (µg/L)	Monthly Average WQBEL[1] (µg/L)	PEQ > WQBEL?	Daily Maximum PEQ (µg/L)	Daily Maximum WQBEL[1] (µg/L)	PEQ > WQBEL?	
Cadmium	12.0	12.0	No	10.0	21.0	No	No
Copper	46.7	46.0	Yes	64.7	79.0	No	**Yes**
Iron	1,791	3,168	No	2,569	5,488	No	No
Mercury	0.576	0.012	Yes	0.576	0.020	Yes	**Yes**
Selenium	129	150	No	138	260	No	No
Zinc	373	279	Yes	518	483	Yes	**Yes**
Boron	21,719	47,330	No	22,750	82,000	No	No

1. WQBEL based on the 2-year Maximum Monthly Average flows for Outfalls 001 and 007 of 19.8 and 0.37 cfs (12.8 and 0.24 MGD), respectively.

TABLE 10
Comparison of Estimated Effluent Concentrations and TBELs
Scenario 3 – Combined Discharge of Outfalls 001 and 007 to White River with Ash Transport Water (both BA and FA)
IPL Petersburg Generating Station, Pike County

Parameter	Monthly Average Comparison			Daily Maximum Comparison			Estimated Effluent Conc. > ½ TBEL
	Average Estimated Effluent Conc.[1] (µg/L)	Monthly Average TBEL[2] (µg/L)	Estimated Effluent Conc. > ½ TBEL?	Maximum Estimated Effluent Conc.[1] (µg/L)	Daily Maximum TBEL[2] (µg/L)	Estimated Effluent Conc. > ½ TBEL?	
TSS	15,533	29,886	Yes	67,380	99,619	Yes	**Yes**
Oil & grease	2,718	11,710	No	8,002	15,613	Yes	**Yes**
FAC	51.8	199	No	110	498	No	No
Chromium	5.3	173	No	11.0	173	No	No
Copper	16.8	351	No	58.8	351	No	No
Iron	497	995	No	1,976	995	Yes	**Yes**
Zinc	105	878	No	471	878	Yes	**Yes**

1. Estimated effluent concentrations are based on samples collected by GE between October 2011 and May 2012 from the wastewater streams that contribute to the ash pond.
2. Calculated from the applicable effluent guidelines in 40 CFR Part 423 using the combined wastestream formula (CWF).

Scenario 4

Scenario 4 is the combined discharge of Outfalls 001 and 007 to the White River without fly ash or bottom ash handling water. Table 11 is a partial list of the estimated effluent concentrations compared to the WQBELs. Similar to Scenario 2, mercury concentrations exceed half of the estimated permit limit and may result in a permit limit. A complete list of parameters is located in Table A-5. Table 12 shows the estimated effluent concentrations compared to the TBELs. The estimated effluent concentration of boron is slightly below half of the monthly average permit limit. This presents a moderate risk of compliance with future boron limits.

TABLE 11
Partial Results of Estimated Effluent Concentration Comparison to WQBELs
Scenario 4 – Combined Discharge of Outfalls 001 and 007 to White River without Ash Transport Water (neither BA or FA)
IPL Petersburg Generating Station, Pike County

Parameter	Monthly Average Comparison			Daily Maximum Comparison			Greater than ½ Limit?
	Average Estimated Effluent Conc. (µg/L)	Monthly Average WQBEL[1] (µg/L)	Estimated Effluent Conc. >½ Limit?	Maximum Estimated Effluent Conc. (µg/L)	Daily Maximum WQBEL[1] (µg/L)	Estimated Effluent Conc. > ½ Limit?	
Mercury	0.98	0.012	Yes	1.44	0.020	Yes	**Yes**
Selenium	33.7	150	No	66.5	260	No	No
Boron	20,928	47,330	No	21,597	82,000	No	No

1. Estimated effluent concentrations based on the flow for Outfalls 001 and 007 without ash transport water of 9.7 and 0.37 cfs (6.3 and 0.24 MGD), respectively.

TABLE 12
Comparison of Estimated Effluent Concentrations to the TBELs
Scenario 4 – Combined discharge of Outfalls 001 and 007 to White River without Ash Transport Water (neither BA or FA)
IPL Petersburg Generating Station, Pike County

Parameter	Monthly Average Comparison			Daily Maximum Comparison			Estimated Effluent Conc. > 1/2 TBEL?
	Average Estimated Effluent Conc.[1] (µg/L)	Monthly Average TBEL[2] (µg/L)	Estimated Effluent Conc. >½ TBEL?	Maximum Estimated Effluent Conc.[1] (µg/L)	Daily Maximum TBEL[2] (µg/L)	Estimated Effluent Conc. >½ TBEL?	
TSS	30,000	29,687	Yes	30,000	98,956	No	**Yes**
O&G	4,574	5,982	Yes	6,496	7,977	Yes	**Yes**
FAC	--	--	ND	--	--	ND	ND
Chromium	39.3	175	No	47.5	175	No	No
Copper	11.5	56	No	19.1	56	No	No
Iron	8,189	985	Yes	13,362	985	Yes	**Yes**
Zinc	2.4	972	No	5.2	972	No	No

1. Estimated effluent concentrations are based on samples collected by GE between October 2011 and May 2012 from the wastewater streams that contribute to the ash pond.
2. Calculated from the applicable effluent guidelines in 40 CFR Part 423 using the combined wastestream formula (CWF).
ND = No Data.

Scenario 5

Scenario 5 includes relocation of Outfall 001 and Outfall 007 separately to the White River, and includes bottom ash handling waters but not fly ash handling waters (current operating scenario post MATS impact). Outfall 007 does not contain ash handling water and so the evaluation of 007 is the same as presented for Scenario 1.

A comparison of the estimated effluent concentrations to the calculated WQBELs is presented in Table 13 for Scenario 5. Table A-6 in Appendix A-1 is a complete table of results for this comparison for Outfall 001 discharging to White River. Arsenic, copper, iron, and mercury concentrations exceed half of the estimated monthly average limit and daily maximum limit.

Table 14 presents the estimated TBELs and a comparison of the effluent data to half of the TBEL limit.

TABLE 13
Partial Results of Preliminary Effluent Limits Comparison
Scenario 5 – Discharge of Outfall 001 to White River with Bottom Ash Transport Water (BA only)
IPL Petersburg Generating Station, Pike County

Parameter	Monthly Average Comparison			Daily Maximum Comparison			Estimated Effluent Conc. 1/2 PEL?
	Average Estimated Effluent Conc.[1] (μg/L)	Monthly Average WQBEL[2] (μg/L)	Estimated Effluent Conc. >½ PEL?	Maximum Estimated Effluent Conc.[1] (μg/L)	Daily Maximum WQBEL[2] (μg/L)	Estimated Effluent Conc. >½ PEL?	
Arsenic	261	416	Yes	364.2	720	Yes	**Yes**
Copper	50.3	46.0	Yes	96	79.0	Yes	**Yes**
Iron	24,250	3,168	Yes	47,226	5,488	Yes	**Yes**
Mercury	0.574	0.012	Yes	0.9	0.020	Yes	**Yes**
Boron	12,947	47,330	No	14,455	82,000	No	No

1. Estimated effluent concentrations are based on samples collected by GE between October 2011 and May 2012 from the wastewater streams that contribute to the ash pond.
2. WQBELs based on the 2-year Maximum Monthly Average flow for Outfall 001 of 19.8 minus the fly ash flow of 6.1 cfs (12.8 and 3.9 MGD), respectively.

TABLE 14
Comparison of Estimated Effluent Concentrations and TBELs
Scenario 5 – Discharge of Outfall 001 to White River with Bottom Ash Transport Water (BA only)
IPL Petersburg Generating Station, Pike County

Parameter	Monthly Average Comparison			Daily Maximum Comparison			Estimated Effluent Conc. > 1/2 TBEL?
	Average Estimated Effluent Conc.[1] (μg/L)	Monthly Average TBEL (μg/L)	Estimated Effluent Conc. >½ TBEL?	Maximum Estimated Effluent Conc.[1] (μg/L)	Daily Maximum TBEL (μg/L)	Estimated Effluent Conc. >½ TBEL?	
TSS	30,000	29,823	Yes	30,000	99,410	No	**Yes**
O&G	4,124	9,903	No	6,963	13,204	Yes	**Yes**
FAC	--	--	ND	--	--	ND	ND
Total Chromium	77.1	165	No	136.6	165	Yes	**Yes**
Copper	50.3	32	Yes	96.3	32	Yes	**Yes**
Iron	24,250	992	Yes	47,226	992	Yes	**Yes**
Zinc	8.88	811	No	29.28	811	No	No

1. Estimated effluent concentrations are based on samples collected by GE between October 2011 and May 2012 from the wastewater streams that contribute to the ash pond.
ND = No Data.

Scenario 6

Scenario 6 includes relocation of the combined discharge of Outfall Nos. 001 and 007 to the White River, and includes bottom ash handling waters but not fly ash handling waters (operating scenario post MATS operation).

A comparison of the estimated effluent concentrations to the calculated WQBELs is presented in Table 15 for Scenario 6. Table A-7 in Appendix A-1 is a complete table of results for this comparison for Outfall Nos. 001 and 007 discharging to White River. Similar to Scenario 5, arsenic, copper, iron, and mercury concentrations exceed half of the estimated effluent limits.

Table 2 on Page 4 presents the estimated TBELs and a comparison of the effluent data to half of the TBEL limit.

TABLE 15
Partial Results of Preliminary Effluent Limits Comparison
Scenario 6 – Discharge of Outfall Nos. 001 and 007 to White River with Bottom Ash Transport Water (BA only)
IPL Petersburg Generating Station, Pike County

Parameter	Monthly Average Comparison			Daily Maximum Comparison			Estimated Effluent Conc. ½ PEL?
	Average Estimated Effluent Conc. (µg/L)	Monthly Average WQBEL[1] (µg/L)	Estimated Effluent Conc. >½ PEL?	Maximum Estimated Effluent Conc. (µg/L)	Daily Maximum WQBEL[1] (µg/L)	Estimated Effluent Conc. >½ PEL?	
Arsenic	254.7	416	Yes	355.3	720	No	**Yes**
Copper	49.1	46.0	Yes	94.0	79.0	Yes	**Yes**
Iron	23,643	3,168	Yes	46,028	5,488	Yes	**Yes**
Mercury	0.561	0.012	Yes	0.842	0.020	Yes	**Yes**
Boron	12,674	47,330	No	14,143	82,000	No	No

Appendix A-1
Reasonable Potential to Exceed Results

TABLE A-1
Results of Reasonable Potential to Exceed Statistical Procedure
Scenario 1 – Discharge of Outfall 001 to White River With Ash Transport Water (both BA and FA)
IPL Petersburg Generating Station, Pike County

Parameter	Monthly Average Comparison			Daily Maximum Comparison			Reasonable Potential to Exceed?
	Monthly Average PEQ[1] (µg/L)	Monthly Average WQBEL[2] (µg/L)	PEQ > WQBEL?	Daily Maximum PEQ[1] (µg/L)	Daily Maximum WQBEL[2] (µg/L)	PEQ > WQBEL?	
Arsenic	55.8	416	No	70.4	720	No	No
Cadmium	12.0	12.0	No	10.0	21.0	No	No
Chromium	12.6	4,054	No	11.0	7,024	No	No
Copper	48.0	46.0	Yes	66.0	79.0	No	**Yes**
Iron	1,936	3,168	No	3,000	5,488	No	No
Lead	12.6	167	No	11.0	289	No	No
Mercury	0.588	0.012	Yes	0.588	0.020	Yes	**Yes**
Nickel	105	2,045	No	110	4,969	No	No
Selenium	132	150	No	140	260	No	No
Zinc	384	279	Yes	528	483	Yes	**Yes**
Boron	22,550	47,330	No	25,300	82,000	No	No
Fluoride	7,150	13,853	No	8,030	24,000	No	No
Sulfate	1,870,000	31,778,000	No	1,900,000	55,056,000	No	No

1. PEQ = Projected Effluent Quality determined by procedures in 327 IAC 5-2-11.5

2. WQBELs based on the 2-year Maximum Monthly Average flow (2011-2012) for Outfall 001 of 19.8 cfs (12.8 MGD) as set forth by 327 IAC 5-2-11.4(a)(9).

TABLE A-2
Results of Reasonable Potential to Exceed Statistical Procedure
Scenario 1 – Discharge of Outfall 007 to White River with Ash Transport Water (both BA and FA)
IPL Petersburg Generating Station, Pike County

Parameter	Monthly Average Comparison			Daily Maximum Comparison			Reasonable Potential to Exceed?
	Monthly Average PEQ[1] (µg/L)	Monthly Average WQBEL[2] (µg/L)	PEQ >[1] WQBEL?	Daily Maximum PEQ[1] (µg/L)	Daily Maximum WQBEL[12] (µg/L)	PEQ >[1] WQBEL?	
Arsenic	30.0	416	No	25.0	720	No	No
Cadmium	13.0	11.0	Yes	11.0	20.0	No	**Yes**
Chromium	12.6	3,927	No	11.0	6,804	No	No
Copper	28.0	44.0	No	22.0	76.0	No	No
Iron	1,264	3,168	No	1,820	5,488	No	No
Lead	12.6	266.0	No	11.0	461	No	No
Mercury	0.134	0.012	Yes	0.134	0.020	Yes	**Yes**
Nickel	32.9	3,263	No	40.7	5,654	No	No
Selenium	32.5	150	No	27.5	260	No	No
Zinc	74.1	270	No	100	467	No	No
Boron	13,130	47,330	No	12,100	82,000	No	No
Fluoride	1,614	13,853	No	2,530	24,000	No	No

1. PEQ = Projected Effluent Quality determined by procedures in 327 IAC 5-2-11.5
2. WQBELs based on the 2-year Maximum Monthly Average flow (2011-2012) for Outfall 007 of 0.37 cfs (0.24 MGD) as set forth by 327 IAC 5-2-11.4(a)(9)

TABLE A-3
Results of Preliminary Effluent Limits Comparison
Scenario 2 – Discharge of Outfall 001 to White River without Ash Transport Water (neither BA or FA)
IPL Petersburg Generating Station, Pike County

Parameter	Monthly Average Comparison			Daily Maximum Comparison			Greater than ½ Limit?
	Average Estimated Effluent Conc. (µg/L)	Monthly Average Limit[1] (µg/L)	Estimated Effluent Conc. >½ Limit?	Maximum Estimated Effluent Conc. (µg/L)	Daily Maximum Limit[1] (µg/L)	Estimated Effluent Conc. >½ Limit?	
Arsenic	125.4	416	No	128.7	720	No	No
Cadmium	1.3	12.0	No	2.7	21.0	No	No
Chromium	41.2	4,054	No	49.8	7,024	No	No
Copper	11.9	46.0	No	19.6	79.0	No	No
Iron	8,569	3,168	Yes	13,978	5,488	Yes	Yes
Lead	0.8	280	No	2.3	485	No	No
Mercury	1.025	0.012	Yes	1.511	0.020	Yes	Yes
Nickel	75.0	3,373	No	86.5	5,844	No	No
Selenium	35.4	150	No	69.8	260	No	No
Zinc	0.17	279	No	0.34	483	No	No
Boron	21,875	47,330	No	22,574	82,000	No	No
Fluoride	2,779	13,853	No	3,176	24,000	No	No
Sulfate	815,604	62,962,000	No	1,453,824	109,083,000	No	No

1. PEL based on the estimated flow for Outfall 001 without Ash Transport Water of 9.7 cfs (6.3 MGD).

TABLE A-4
Results of Reasonable Potential to Exceed Statistical Procedure
Scenario 3 – Combined Discharge of Outfalls 001 and 007 to White River with Ash Transport Water (both BA and FA)
IPL Petersburg Generating Station, Pike County

Parameter	Monthly Average Comparison			Daily Maximum Comparison			Reasonable Potential to Exceed?
	Monthly Average PEQ (µg/L)	Monthly Average WQBEL[1] (µg/L)	PEQ > WQBEL?	Daily Maximum PEQ (µg/L)	Daily Maximum WQBEL[1] (µg/L)	PEQ > WQBEL?	
Arsenic	50.4	416	No	63.1	720	No	No
Cadmium	12.0	12.0	No	10.0	21.0	No	No
Chromium	11.6	4,054	No	11.0	7,024	No	No
Copper	46.7	46	Yes	64.7	79	No	Yes
Iron	1,791	3,168	No	2,569	5,488	No	No
Lead	11.6	164	No	11.0	284	No	No
Mercury	0.576	0.012	Yes	0.576	0.020	Yes	Yes
Nickel	95	2,009	No	95	4,883	No	No
Selenium	129	150	No	138	260	No	No
Zinc	373	279	Yes	518	483	Yes	Yes
Boron	21,719	47,330	No	22,750	82,000	No	No
Fluoride	6,889	13,853	No	7,671	24,000	No	No
Sulfate	1,688,293	31,222,000	No	1,883,391	54,092,000	No	No

1. WQBEL based on the 2-year Maximum Monthly Average flows for Outfalls 001 and 007 of 19.8 and 0.37 cfs (12.8 and 0.24 MGD), respectively.

TABLE A-5
Results of Estimated Effluent Concentration Comparison to WQBELs
Scenario 4 – Combined Discharge of Outfalls 001 and 007 to White River without Ash Transport Water (neither BA or FA)
IPL Petersburg Generating Station, Pike County

Parameter	Monthly Average Comparison			Daily Maximum Comparison			Greater than ½ Limit?
	Average Estimated Effluent Conc.[1] (µg/L)	Monthly Average Limit[1] (µg/L)	Estimated Effluent Conc. >½ Limit?	Maximum Estimated Effluent Conc. (µg/L)	Daily Maximum Limit[1] (µg/L)	Estimated Effluent Conc. >½ Limit?	
Arsenic	120	416	No	124	720	No	No
Cadmium	1.4	12.0	No	2.9	21.0	No	No
Chromium	39.3	4,054	No	47.5	7,024	No	No
Copper	11.5	46.0	No	19.1	79.0	No	No
Iron	8,189	3,168	Yes	13,362	5,488	Yes	**Yes**
Lead	0.87	280	No	2.4	485	No	No
Mercury	0.98	0.012	Yes	1.44	0.020	Yes	**Yes**
Nickel	71.4	3,373	No	82.4	5,844	No	No
Selenium	33.7	150	No	66.5	260	No	No
Zinc	2.4	279	No	5.2	483	No	No
Boron	20,928	47,330	No	21,597	82,000	No	No
Fluoride	2,677	13,853	No	3,060	24,000	No	No
Sulfate	775,899	60,709,000	No	1,837,379	105,178,000	No	No

1. PEL based on the flow for Outfalls 001 and 007 without ash transport water of 9.7 and 0.37 cfs (6.3 and 0.24 MGD), respectively.

TABLE A-6
Results of Reasonable Potential to Exceed Statistical Procedure
Scenario 1 – Discharge of Outfall 001 to White River With Bottom Ash Transport Water (no FA)
IPL Petersburg Generating Station, Pike County

Parameter	Monthly Average Comparison			Daily Maximum Comparison			Estimated Effluent Conc. ½ PEL?
	Average Estimated Effluent Conc.[1] (µg/L)	Monthly Average PEL[1] (µg/L)	Estimated Effluent Conc. > ½ PEL?	Maximum Estimated Effluent Conc.[1] (µg/L)	Daily Maximum PEL[1] (µg/L)	Estimated Effluent Conc. >½ PEL?	
Arsenic	261	416	Yes	364.2	720	Yes	**Yes**
Cadmium	1.8	12.0	No	3.2	21.0	No	No
Chromium	77.1	4,054	No	137	7,024	No	No
Copper	50.3	46.0	Yes	96	79.0	Yes	**Yes**
Iron	24,250	3,168	Yes	47,226	5,488	Yes	**Yes**
Lead	22.4	255	No	47.6	442	No	No
Mercury	0.574	0.012	Yes	0.9	0.020	Yes	**Yes**
Nickel	105.9	3,138	No	162.9	5,844	No	No
Selenium	23.7	150	No	45.5	260	No	No
Zinc	8.9	279	No	29.3	483	No	No
Boron	12,947	47,330	No	14,455	82,000	No	No
Fluoride	1,825	13,853	No	2,330	24,000	No	No
Sulfate	551,062	48,765,000	No	971,048	84,486,000	No	No

1. WQBEL based on the 2-year Maximum Monthly Average flow for Outfalls 001 (12.13 MGD) minus the fly ash transport flow of 3.9 MGD; 8.2 MGD.

TABLE A-7

Results of Reasonable Potential to Exceed Statistical Procedure
Scenario 1 – Discharge of Outfall 001 and 007 to White River With Bottom Ash Transport Water (no FA)

IPL Petersburg Generating Station, Pike County

Parameter	Monthly Average Comparison			Daily Maximum Comparison			Estimated Effluent Conc. ½ PEL?
	Average Estimated Effluent Conc. (µg/L)	Monthly Average PEL[1] (µg/L)	Estimated Effluent Conc. >½ PEL?	Maximum Estimated Effluent Conc. (µg/L)	Daily Maximum PEL[1] (µg/L)	Estimated Effluent Conc. >½ PEL?	
Arsenic	254.7	416	Yes	355.3	720	No	**Yes**
Cadmium	1.9	12.0	No	3.2	21.0	No	No
Chromium	75.1	4,054	No	133.1	7,024	No	No
Copper	49.1	46.0	Yes	94.0	79.0	Yes	**Yes**
Iron	23,643	3,168	Yes	46,028	5,488	Yes	**Yes**
Lead	21.9	231	No	46.5	399	No	No
Mercury	0.561	0.012	Yes	0.842	0.020	Yes	**Yes**
Nickel	103.2	2,834	No	158.7	5,844	No	No
Selenium	23.2	150	No	44.4	260	No	No
Zinc	9.8	279	No	31.1	483	No	No
Boron	12,674	47,330	No	14,143	82,000	No	No
Fluoride	1,795	13,853	No	2,290	24,000	No	No
Sulfate	536,820	44,046,000	No	945,719	76,310,000	No	No

1. PEL based on the combined flow for Outfalls 001 and 007 (13.04 MGD) without fly ash transport water (3.9 MGD); 9.1 MGD

Appendix A-2
Boron Monitoring Results for Outfalls 001 and 007

TABLE B-1
Outfall 001 Boron Data
IPL Petersburg Generating Station, Pike County

Date	Flow (MGD)	Boron (mg/L)	Monthly Average Boron (mg/L)
10/2/2012	11.01	19	18
10/10/2012	9.61	17	
11/2/2012	13.26	14	14.5
11/15/2012	10.85	15	
12/4/2012	12.96	18	18
12/13/2012	9.08	18	
1/3/2013	10.15	23	18.5
1/17/2013	13.67	14	
2/5/2013	12.45	18	19
2/19/2013	11.01	20	
3/7/2013	11.48	20	19.5
3/14/2013	8.93	19	
4/1/2013	11.92	20	20
4/17/2013	14.85	20	
5/2/2013	10.89	22	20.5
5/10/2013	9.62	19	
6/3/2013	12.12	19	18.5
6/13/2013	12.98	18	
7/4/2013	15.11	18	19
7/11/2013	11.05	20	
8/1/2013	7.26	18	16
8/8/2013	15.33	14	
9/4/2013	11.01	20	19
9/12/2013	11.96	18	

TABLE B-2
Outfall 007 Boron Data
IPL Petersburg Generating Station, Pike County

Date	Flow (MGD)	Boron (mg/L)	Monthly Average Boron (mg/L)
10/3/2012	0.240	2.8	2.9
10/17/2012	0.160	3.0	
11/2/2012	0.240	2.7	2.65
11/17/2012	0.240	2.6	
12/4/2012	0.240	2.9	3.2
12/13/2012	0.240	3.5	
1/3/2013	0.240	3.5	2.95
1/28/2013	0.240	2.4	
2/5/2013	0.240	2.0	2.3
2/19/2013	0.240	2.6	
3/1/2013	0.240	2.7	2.9
3/13/2013	0.160	3.1	
4/1/2013	0.240	2.8	3.25
4/11/2013	0.160	3.7	
5/4/2013	0.730	2.1	2.1
5/14/2013	0.450	2.1	
6/3/2013	0.450	1.5	1.5
6/13/2013	0.240	1.5	
7/2/2013	0.240	2.1	2.45
7/10/2013	0.240	2.8	
8/1/2013	0.240	3.0	2.95
8/8/2013	0.240	2.9	
9/5/2013	0.240	3.5	3.35
9/12/2013	0.240	3.2	

Appendix B
Harding Street Station
Compliance Alternative Evaluation

DRAFT TECHNICAL MEMORANDUM CH2MHILL®

Indianapolis Power & Light Company (IPL) - Harding Street – Effluent Metals Wastewater Treatment Study - Design Basis and Alternative Selection

PREPARED FOR:	David Kehres/IPL Nysa Hogue/IPL David Heger/IPL
PREPARED BY:	CH2M HILL
DATE:	Phase 1 Draft: November 9, 2012 Phase 2 Draft: January 4, 2013 Revised with most recent version of CSP

Introduction

CH2M HILL evaluated options for compliance with new National Pollutant Discharge Elimination System (NPDES) permit limits for Outfall No. 006 for IPL's Harding Street Station. This technical memorandum (TM) presents a summary of the project's design basis and the alternative evaluation process. The alternatives were narrowed down to the selected compliance strategy in phases. In each phase, treatment costs were estimated to aid in decision making. After each phase, the number of alternatives were refined. It should be noted that costs for each alternative changed through the process as the designs were refined. These changes did not affect the decisions made in earlier phases.

Overall Approach

The current wastewater management approach at both stations is to co-manage process wastewater (other than once-through cooling water) in pond-based treatment. After determining that the current wastewater management approach, including the discharge of individual or combined streams, is not adequate to meet the new NPDES permit limits, CH2M HILL considered whether wastewater streams should be treated combined or segregated, and which streams should be managed by source control rather than treated.

It was determined that the process wastewaters should be separated into three wastewater groups: 1) FGD water, 2) ash transport water, 3) other wastewaters. The team also determined that fly ash water should be eliminated rather than treated. This approach was chosen because:

- **FGD water** is recommended for segregated treatment because FGD water is a concentrated, lower-flow source of several of the trace metals that have NPDES permit limits. Treating it separately represents an opportunity for lower-flow and therefore lower cost treatment.
- **Fly ash.** The team determined that fly ash water should be managed separately, as it is source of pollutants with NPDES discharge limits. The options available include: elimination of wet fly ash handling, continued treatment in ponds, building tank-based treatment, and closed-loop reuse of fly ash water.
  - Treatment in ponds was eliminated because of high risk of non-compliance with NPDES discharge limits (especially selenium and mercury).

- Reuse of fly ash water was not recommended because fly ash contributes anions to water (such as chlorides and sulfate) and represents a high operability risk due to scaling and corrosion.
- Dry fly ash handling was chosen rather than tank-based treatment because it offered a lower risk and lower cost than treating the fly ash water to NPDES discharge limits either by itself or combined with other streams. Both IPL stations already have some infrastructure in place to handle ash dry, which assists in the elimination of wet fly ash handling. Dry fly ash handling also eliminates the risk that changes due to MATS compliance (such as carbon injection) will change the fly ash water making it harder to treat to compliance.

- **Bottom Ash and Other wastewater** streams are recommended to be treated separately from each other. Segregation of bottom ash water from Other water is recommended as it will allow the bottom ash water to be reused (if desired now or in future) since it is lower in corrosive salts than the remaining wastewaters (which have significant concentration of salts from cooling tower blowdown and source water treatment residuals). The remaining wastewaters (i.e., non-CCR containing water) can be managed and treated with fewer regulatory requirements than if ash-containing (CCR) water is included.

Design Basis

The design basis for evaluating overall approach options consists of: wastewater flow, wastewater quality, and discharge limits.

Effluent Water Quality Limits

Effluent Water Quality Limits - Current Permit for Discharge to Lick Creek

The current permit's effluent water quality limits are shown in **Table 1**.

TABLE 1
Permit Limits in Current NPDES Permit for Outfall Nos. 006 (Ash Pond Discharge) and 101 (FGD Discharge)[1]

		006 (Ash Pond)[1]		
Parameter	**Units**	**Effective Date [3]**	**Monthly Average**	**Daily Maximum**
TSS	mg/L	Oct. 2012	30	99
O&G	mg/L	Oct. 2012	15	20
Mercury[2]	ng/L	Final (Sep. 2017)	12	20
Selenium[2]	mg/L	Final (Sep. 2017)	0.029	0.058
Cadmium[2]	mg/L	Final (Sep. 2017)	0.0022	0.0045
Copper[2]	mg/L	Interim (Oct. 2012)	0.03	0.06
	mg/L	Final (Sep. 2017)	0.025	0.05
Chromium[2]	mg/L	Jun. 2013	0.2	0.2
Zinc[2]	mg/L	Jun. 2013	0.22	0.45
Iron[2]	mg/L	Oct. 2012	1.0	1.0
pH	s.u.	Oct. 2012	--	6.0 to 9.0
Total Residual Chlorine	mg/L	Oct. 2012	0.01	0.02

Notes:

[1] Outfall No. 006 has report-only requirements for aluminum, ammonia as nitrogen (N), arsenic, boron, cadmium (interim), chlorides, flow, lead, manganese, mercury (interim), nickel, phosphorus, selenium (interim), sulfate, and total dissolved solids (TDS).

Outfall No. 101 (FGD), not shown, has report-only requirements for ammonia as N, arsenic, boron, biochemical oxygen demand (BOD), cadmium, chlorides, chromium, copper, flow, iron, lead, manganese, mercury, O&G, pH, phosphorus, selenium, TDS, total suspended solids (TSS), and zinc. The report-only requirements take effect on the date of permit issuance.

[2] The identified metals are as total recoverable.

[3] The NPDES Permit requires compliance with the final permit limits no later than October 1, 2015, which was extended to September 29, 2017, in the Agreed Order for Case No. 2013-21498-W. Interim limits apply until the final limits become effective. The NPDES Permit was modified on May 8, 2013, to include limits for chromium and zinc that became effective on June 1, 2013.

mg/L = milligrams per liter; ng/L = nanograms per liter

Flow

Peak daily flow, expressed in gallons per minute (gpm), will be used to size treatment systems in this evaluation. Flows estimates used in this evaluation are shown in **Table 2**.

TABLE 2
Flow Basis of Design for Harding Street Station Outfall No. 006

Wastewater Source	Source Category	Peak Day Avg Flow (gpm)	Source	Comments
Coal Pile Runoff	Other	0	Personnel Interview	No flow from coal pile runoff
Unit 7 Waste Pit	Other	370	GE Flow Model	3 pumps - 2 service - 2,000 gpm (pumps sized for Unit 7 bottom ash seal trough overflow,

TABLE 2
Flow Basis of Design for Harding Street Station Outfall No. 006

Wastewater Source	Source Category	Peak Day Avg Flow (gpm)	Source	Comments
				which is most of the flow to this pit).
Cinder Pit	Other	219	GE Flow Model	2 pumps – 1,600 gpm (pumps sized for Units 5 & 6 ash overflow)
Unit 7 Cooling Tower	Other	1,239	GE Flow Model	Continuous blowdown
Subtotal - Other Water		**1,828**		
Unit 7 Top Ash	Ash	1,875	Personnel Interview and Design Drawings	Pulled 1x per shift for 6-hour, 3 shifts per day
Unit 7 Bottom Ash	Ash	625	Personnel Interview and Design Drawings	Pulled 1x per shift for 2 hours, 3 shifts per day
Unit 7 Seal Water / Ash Seal Trough	Ash	400	Personnel Interview and UCC Comments	Added during preliminary design. See Note 1.
Subtotal - Ash Water		**2,900**		
Gypsum Wash Water	FGD	0	Personnel Interview	Wash goes to reclaim tank
FGD Storage Tank Effluent	FGD	312	GE Flow Model	2 shifts X 8 hours
Subtotal - FGD Water		**312**		

Notes:
[1] Boiler seal water included in both Other water and Ash water groups' design basis. EPC bid specification base case will not include this flow in Ash Water, and will ask for optional pricing with it included in Ash Water. Seal trough water (which carries small amounts of bottom ash) will continue to flow to Unit 7 waste sump, and from their along with other Unit 7 waste sump it will be pumped to the Other Water treatment system. (The system may be modified in the future to re-route this seal trough water to be managed with bottom ash water.)

Water Quality

To evaluate which pollutants would need to be removed to meet discharge limits, CH2M HILL compared available water quality data to the permit limits. This is shown in **Table 3**. Discharge monitoring report (DMR) data were evaluated against permit limits to identify parameters needing treatment initially. This comparison indicates parameters that require treatment per the NPDES permit's final limits. This analysis indicates that for Outfall No. 006, treatment for mercury, selenium, cadmium and iron likely would be required.

Wastewater management alternatives were developed by first evaluating which wastewater streams were causing the regulated plant outfalls to have metals loading above the current limits. This evaluation showed that treatment is needed, and identified which streams required treatment for which metals.

TABLE 3
Pollutants with Numeric Limits in October 2012 NPDES Permit – Harding Street Outfall No. 006

DMR MONITORING DATA FROM OCTOBER 2012 TO DECEMBER 2013

		NPDES Permit Limits			Historical Monitoring		% of Samples Above Daily Limit	% of Samples Above Monthly Average Limit
Parameter	Unit	Effective Date	Monthly Avg	Daily Max	Avg	Max	%	%
Copper	mg/L	Sep. 2017	0.025	0.05	0.02	0.04	0%	20%
Cadmium	mg/L	Sep. 2017	0.0022	0.0045	See Note 3	0.008	See Note 3	See Note 3
Mercury	ng/L	Sep. 2017	12	20	113	164	100%	100%
Selenium	mg/L	Sep. 2017	0.029	0.058	0.08	0.20	72%	100%
TSS	mg/L	Oct. 2012	30	99	14	26	0%	0%
O&G	mg/L	Oct. 2012	15	20	2.6[1]	5.0	0%	0%
Iron	mg/L	Oct. 2012	1.0	1.0	0.6	1.5	14%	7%
TRC	mg/L	Oct. 2012	0.01[2]	0.02[2]	<0.02	<0.02	NA	NA
pH	s.u.	Oct. 2012	--	6.0 to 9.0	--	7.2 to 8.2	0%	0%

Notes:
Red highlighted cells indicate values that are greater than the limit.
[1] For oil and grease samples that were not detected, one-half of the detection limit was used for the calculation of the average. The non-detect level is 5 mg/L, which is also well below the permit limit.
[2] The limit for total residual chlorine (TRC) is less than the limit of quantitation (LOQ); compliance with the limit is demonstrated if effluent concentrations measured are less than the LOQ of 0.06 mg/L. Measurements above the limit and above the limit of detection (LOD) of 0.02 mg/L are associated with source identification requirements and increased monitoring.
[3] Used 20 results over 10 months for cadmium. 17 of the results were reported as <0.005 mg/L. The other three were 0.005, 0.006, and 0.008 mg/L. In each of the three months with a quantified result, the other result was <0.005 mg/L.

Water quality data currently available are primarily from GE's 2011 - 2012 study, and were typically one to three data points per wastewater stream. For streams being discharged, there is additional monitoring data. Water quality for a wastewater group was estimated using the flow-weighted average of the various streams that make up that group. For example, the Other wastewater was calculated based on data collected for the Unit 7 Waste Pit, the Cinder Pit, and the Unit 7 Cooling Tower.

Data on soluble concentrations in wastewater were used because it was assumed that particulate metals would be removed by settling – either in ponds or tank-based treatment. The maximum values in the data sets were compared to one-half the discharge limit, representing a safety factor for operations. The pollutants that had maximum soluble concentrations higher than one-half the new NPDES discharge limits, and therefore are considered as likely needing treatment beyond just settling, are shown in **Table 4**.

TABLE 4
Comparison of Calculated Wastewater Characteristics to Permit Limit – Harding Street

Parameter	Limits for Evaluation	FGD	Fly Ash	Other[1]	FGD + Other[1]	Bottom Ash	Bottom Ash + Other[1]
Flow, gpm		468	2,500	8,769	9,237	2,500	11,269
Copper, Filtered, mg/L	0.025	0.025	0.025	0.039[2]	0.038	0.008	0.032[2]
Cadmium, Filtered, mg/L	0.0022	0.043	0.020	0.008[2]	0.010	0.0002	0.007[2]
Mercury, Filtered, ng/L	12	7,580	12	29	412	3	23
Selenium, Filtered, mg/L	0.029	0.763	0.188	0.029	0.066	0.026	0.028
Oil and Grease, mg/L	15	6	<6	6	6	<6	6
Iron, Filtered, mg/L[3]	1	0.180	0.04	0.11	0.11	0.18	0.13

Notes:
Maximum soluble concentrations from data set shown.
Source: GE's 2012 Water Management Study.
Red highlighted cells indicate values that are greater than half the limit.
Permit has limit on TSS of 30 mg/L. All wastewater groups have over 30 mg/L TSS, but all can be settled to less than 30 mg/L by ponds.
[1] The Other Water is expected to be lower once regenerant waste removed from Unit 7 sump, and when new tank-based treatment is done.
[2] Total metal concentrations were used in the absence of soluble pollutant concentrations, which impacted the footnoted values. The pollutants for which total concentrations were used are the Other 7-1 & 7-2 Waste Pit cadmium and copper. Therefore, though there may be some risk, it cannot be assessed with available information.
[3] Values in this table are calculated based on soluble concentrations in each stream. Table does not reflect equipment washes. CH2M HILL's opinion is that the iron exceedances to date are related to particulate iron and/or equipment washes.

It was determined that the FGD wastewater, the Fly Ash transport water, the Other wastewater, and possibly the Bottom Ash transport water will require additional treatment beyond just settling within the existing ash pond system in order to comply with the NPDES permit limits.

The bottom ash transport water has some compliance risk if treated only by settling. There was only one parameter in one sample out of four samples of soluble metals in bottom ash water greater than one-half the discharge limit. This was selenium, present just below the limit in one sample. Bottom ash does not typically leach much selenium. And Other Water should have lower selenium and help dilute selenium in the Bottom Ash Water, though this is hard to verify because Other Water data affected by regenerant waste and fly ash to Unit 7 sump. Therefore, discharging bottom ash water at Harding Street is considered to have low-to-moderate risk of selenium non-compliance until actual water from Unit 7 sump can prove how much selenium dilution there will be. It is problematic to predict selenium concentrations until the change to Unit 7 sump are made. It was therefore determined that bottom ash transport water will require additional treatment beyond just settling within the existing ash pond system in order to comply with the NPDES permit limits.

Considerations and Potential Risks Associated with Wastewater Management Options

The following items were considered in evaluating the overall approach include:

- Current National Pollutant Discharge Elimination System (NPDES) permit limits. This permit sets numeric limits, most derived from water quality based effluent limit calculations. Periodic (weekly, monthly, bimonthly) compliance sampling is required.
- Pending/Future Federal Regulations:

- While IDEM states in the NPDES permit that the permit may be modified, or alternately, revoked and reissued to comply with any revisions to the federal effluent guidelines applicable to this facility, i.e., the Steam Electric Power Generating effluent guidelines (40 CFR Part 423), if the revised guideline is issued or approved and contains different conditions than those in the permit, the new ELG limits will likely be incorporated during the next renewal of IPL's permits which is anticipated in the fall of 2017.

  Information from the U.S. Environmental Protection Agency (EPA) indicates that they are considering the following requirements in the final ELG:

  - Prohibit discharge of fly ash transport water (industry views as likely).
  - Prohibit discharge of bottom ash transport water.
  - Compliance point with technology-based limits on FGD water prior to mixing with other wastewater. These limits may be very low, to the point that zero liquid discharge (ZLD) may be required.
  - Compliance point with technology-based limits on landfill leachate.
  - Clarification of ELG requirements on metal cleaning waste.
- Pending CWA 316(a) IDEM guidance might affect IPLs approval of variances from thermal effluent limits such that closed cycle cooling is required. This would create more cooling tower blowdown to be managed in compliance with NPDES limits. At this time, IPL believes there is low risk that the 316(b) will trigger the need for closed-cycle cooling system for Harding Street Units 5 and 6 based on the proposed rule. However, this rule is not final and will be evaluated further upon final promulgation. At this time, IPL believes there is low risk that 316(a) will trigger the need for closed-cycle cooling systems for Harding Street Units 5 and 6 based on the past alternative thermal effluent limits (ATELs). However, IPL plans to perform an updated thermal demonstration study and upon completed this issue will be further evaluated.
- Pending CWA 316(b) rules may result in IPL deciding to construct additional cooling towers as a method of reducing intake flows and complying with this regulation. This would create more cooling tower blowdown to be managed in compliance with NPDES limits.
- Coal Combustion Residuals (CCR) management may be affected by regulation or possibly legislation. EPA issued a Draft CCR Rule in June 2010, but its progress has been stalled. This rule will potentially either require ponds containing CCRs (such as ash and FGD solids) to be closed, or will require the ponds to have a composite liner, leachate collection, groundwater monitoring, risk evaluations based on location, and closure plans that would make them much more expensive. IPL has previously done a study on the Draft CCR Rule of 2010. This study determined that in order to comply with the Rule as proposed IPL would be required to phase out the use of CCR ponds.

• Other Risks:

- Unproven/Emerging Technology. Some of the treatment technologies being considered have only a few applications treating the wastewater streams needing treatment. The area with least full-scale application is FGD water treatment by biological or thermal ZLD treatment. Even the treatment system used by EPA to define Best Available Technology (BAT) for FGD water of physical/chemical treatment plus biological treatment does not meet the ELG limits consistently at all the plants it is currently used for. This was described in comments by EPRI, UWAG, and Duke Energy to the EPA on the proposed ELG.
- The forecasts of future discharge water quality are based on limited available data. Some streams, most notably bottom ash water, have only a few data points to use in forecasting compliance with discharge limits.

Wastewater Management Options Considered

The treatment technologies considered are summarized in **Table 5**. Information and figures on these treatment options were included in various meeting presentations. Other treatment options were evaluated but rejected near the project onset because having no applications with similar wastewater, 'fatal flaw' risks, and/or due to professional judgment that costs would be significantly higher than other treatment technologies. These are summarized in **Table 6**.

In addition to treatment, outfall relocation to the White River was evaluated as a possible wastewater compliance approach. Since the water quality based limits are based on discharge to a near-zero low-flow creek (i.e., Lick Creek), there was a possible opportunity to obtain some relief from these limits by relocating the discharge. To this end, CH2M HILL calculated the projected effluent quality and WQBELs for three White River discharge scenarios: 1) Outfall No. 006, 2) Outfall No. 006 without any ash transport water (fly ash or bottom ash), and 3) Outfall No. 006 without fly ash transport water (including bottom ash). However, these discharge options did not result in increases to the effluent limits that would reduce the required treatment strategies. In particular, the White River offers only a small increase to discharge limits for parameters key to the treatment cost required (e.g., selenium) compared to the Lick Creek limits, hence treatment of selenium would still be required. Therefore, discharge relocation is not feasible for purposes of overall compliance, nor does it provide significant reduction of risk or overall cost of compliance.

TABLE 5
Wastewater Management Options Considered

Management Option	Description	Risk of Non-Compliance with Discharge Limits	Likelihood of Noncompliance with Future Regulations based on Proposed Rules	Risk of Operations Reliability Problems	Land Requirements	Eliminates CCR Ponds?
Pond treatment	Continuing to treat wastewater in ponds as is currently done	High risk of non-compliance if continuing to send all wastewater streams because historic effluent data show many occurrences of effluent above the pending discharge limits. May be lower risk for cleaner water streams (such as bottom ash water).	High probability of risk if future CCR requirements drive IPL to line and/or close ponds. High probability of risk for ELG non-compliance.	Low-to-moderate risk. Dredging to maintain pond volume required	Uses existing ponds, but these do require dredging and storage of dredged solids.	No. If ponds used for CCR (FGD or Ash) would mean modifying ponds to be in compliance with CCR rule, or would need to close ponds and add tank-based physical/chemical treatment. Therefore, risk that investment in enhanced pond system would be lost. Appears CCR rule would require compliance in 5 to 7 years after issued final (which is anticipated in late-2014). If ponds used for non-CCR streams (such as cooling tower blowdown), this would not be a risk.
Enhanced Pond treatment	Treat wastewater in ponds, but would also include adding chemical feed system and mix tanks to convert some soluble or small particulate metals into larger solids that will be removed in the ponds. A liner may be required if building over existing ponds. Liner recommended for the "Other Water" group, since it does not have much solids to form a layer atop the old solids.	High risk of non-compliance for streams that have selenate above Se discharge limit (Fly Ash, FGD). Moderate-high risk for streams that have soluble mercury above Hg discharge limit (Fly Ash, FGD).	High probability of risk if future CCR requirements drive IPL to close ponds/location restrictions. High probability of risk for ELG non-compliance associated with FGD and Ash Sluice WWs.	Low-to-moderate risk. Solids removal from enhanced pond will be needed periodically.	Uses existing pond area, but these do require dredging and storage of dredged solids. A liner may need to be added. Adding the tanks for enhancing will require roughly 0.1 acre.	
Tank-based physical or physical/chemical treatment	Constructed treatment plant with physical liquid/solid separation through clarifiers and subsequent dewatering of solids (e.g., filter press). May also include filter. May include chemical feed systems and mix tanks to help removal of dissolved parameters. If used for bottom ash or "other" water, would include bottom ash removal as first step (such as with a submerged flight conveyor) for bottom ash treatment option only.	Lower risk of non-compliance for those parameters removed by physical/ chemical treatment (cationic metals such as Cu, Ni, Cd, selenite such as Bottom Ash). Moderate risk for Hg due to very low limits (Fly Ash and FGD). High risk for parameters not removed by physical/chemical treatment (selenate, boron, chloride) (FGD and Fly Ash).	Solids separation is needed as pre-treatment for other forms of treatment considered (biological, ZLD with recycle). Hence, there is low probability of risk that this technology would not be incorporated into future system. If treatment and discharge used for bottom ash, there is moderate probability of risk that ELG will ban this discharge. High probability of risk with fly ash. Moderate probability of risk with bottom ash based on proposed ELG. Low risk for "other" water based on proposed ELG. Risk for CCR - low	Low-moderate risk. Requires more operator attention than pond-based. Well-proven technology. Must monitor and adjust chemical feed systems to maintain optimal treatment.	Rough estimate of 6 acres for a campus of physical/chemical systems for FGD, Ash, and Other streams.	Yes.
Dry fly ash handling	Eliminate discharge of fly ash transport water through use of vacuum and/or pressure dry fly ash transport systems.	None, as wastewater discharge is eliminated.	None	Low risk (dry fly ash handling is a well-proven technology)	Small	Yes
Passive biological treatment (downstream of pond or physical/chemical treatment)	Constructed system consists of lined, in-ground biological reactors. Filled with organic material. Can also use supplemental liquid carbon source feed system, if needed. Bacterial processes used to remove selenate. May also help treat other pollutants.	Moderate-High compliance risk with selenium limits in NPDES permit. Moderate Hg compliance risk.	Moderate probability of risk because if future limits necessitate ZLD (such as boron), would no longer have need for biological treatment. Moderate-high probability of risk of meeting ELG selenium limits on FGD water. Low-moderate probability of risk that final CCR will regulate these type of surface impoundments.	Moderate risk (because reliant on multiple processes: physical/chemical and biological).	Land requirement is a function of nitrates in wastewater. Likely will be requiring over 15 acres to treat the stations FGD wastewater.	Yes (assumes system would be built in lined, CCR-compliant ponds)

TABLE 5
Wastewater Management Options Considered

Management Option	Description	Risk of Non-Compliance with Discharge Limits	Likelihood of Noncompliance with Future Regulations based on Proposed Rules	Risk of Operations Reliability Problems	Land Requirements	Eliminates CCR Ponds?
Tank-based biological treatment (downstream of pond or physical/chemical treatment)	Constructed treatment plant with chemical feed system (for carbon source), bioreactor, and would use same dewatering as physical/chemical system. Bacterial processes used to remove selenate. Will also help treat other pollutants such as Hg. Multiple configurations were considered: fixed bed bioreactors (such as the GE ABMet) and fixed film in fluidized bed reactor (FBR) or mixed bed biological reactor (MBBR). GE ABMet was carried further in evaluation because FBR not used full-scale on FGD water.	Low-Moderate risk of selenate compliance risk. More proven in FGD water than passive – six known systems versus two for passive. Lowers Hg compliance risk by polishing Hg after physical/chemical treatment.	Moderate probability of risk because if future limits necessitate ZLD (such as boron) and/or ELG Se limits remain low or more stringent, would no longer have need for biological treatment.	Moderate risk (because reliant on multiple processes: physical/chemical and biological). Requires more operator attention than passive. Must monitor and adjust chemical feed systems to maintain optimal treatment. If biological system's bacterial population inhibited or killed, can take weeks to recover treatment.	Requires about 2 acres per biological treatment system, when added to a treatment campus.	Yes.
Zero valent iron (ZVI)	Constructed treatment plant with chemical mix tanks, clarifiers, dewatering (filter press). ZVI reacts with trace pollutants, including selenate.	Moderate-high as no full-scale systems in service on FGD water.	Moderate probability of risk because if future limits necessitate ZLD (such as boron), would no longer have need for biological treatment. Also, this system may necessitate the need for treatment after ZVI to remove ammonia (ammonia was generated during the bench-scale treatment of ZVI).	Moderate-High risk (unproved in full-scale).	Not estimated	Yes.
Thermal zero liquid discharge (ZLD)	Uses electric power and/or steam to distill off water. Two levels evaluated: 1. Evaporator – produces a brine (which can be disposed of by using for wetting fly ash) 2. Crystallizer – further reduces brine to a salt cake. This option would likely require softening water in physical/chemical.	Low risk. Eliminates discharge, hence no risk of non-compliance.	Low probability of risk.	Moderate risk (because reliant on multiple processes: physical and thermal ZLD).	Requires approximately 2 acres.	Yes.
ZLD by reuse	Reuse in plant. Suitable for low-salt wastewater (Bottom Ash Transport water, some "Other Wastewater" streams).	Low risk. Eliminates discharge, hence no risk of non-compliance.	Low probability of risk.	Low risk (assumes good solids removal so does not cause abrasion or fouling in reuse system).	Little land use.	N/A (could be used with ponds or tank-based treatment).

TABLE 6
Alternatives Evaluated Early and Rejected

Water Group	Compliance Strategy Option Evaluated	Evaluation
FGD	Reverse Osmosis	Risk of scaling membranes, requires treatment of brine, not used on FGD water elsewhere.
FGD	Boron treatment by precipitation and ion exchange	Done at only one plant (Cayuga), which has much higher discharge limits than the 8 mg/L limit IPL faces. The treatment system has had significant operational challenges.

Alternatives Evaluation – Phase 1

Alternatives were evaluated by considering the various treatment options for each of the three wastewater streams (FGD, Ash, and Other). Initially, 37 permutations of treatment were considered, with costs developed for each, as shown in **Table 7**. Justifications for elimination are shown in the notes section of the table and include the following:

- Eliminated options which included treating wastewater streams together that increased risk of non-compliance.
- Eliminated options which viewed as having high risk of non-compliance with current discharge limits such as FGD water by pond-based (not likely to comply with Hg or Se limits) or physical/chemical treatment (not likely to comply with Se limits) for FGD water.
- Eliminated options that included more treatment than was considered needed.

TABLE 7
Initial Alternatives Evaluated – With Results of Screening Done October 2012 (“Overall Approach” Phase)

#	Screening per discussion Oct 24, 2012	Description
~~1~~	Note 3	~~Segregated trt. FGD: P/C + tank-based bio. Ash: P/C, recycle. Other: Enhanced Pond+ tank-based bio.~~
~~2~~	Note 3	~~Segregated trt. FGD: P/C + passive bio. Ash: P/C, recycle. Other: Enhanced Pond + passive bio.~~
~~3~~	Note 3	~~Segregated trt. FGD: P/C + tank-based bio. Ash: P/C, recycle. Other: P/C+tank-based bio.~~
~~4~~	Note 3	~~Segregated trt. FGD: P/C + tank-based bio. Ash: P/C, recycle. Other: P/C+passive bio.~~
5	Note 1	Segregated trt. FGD: P/C + tank-based bio. Ash: P/C, recycle. Other: P/C.
6	Note 1	Segregated trt. FGD: P/C + passive bio. Ash: P/C, recycle. Other: P/C.
7	Keep	Segregated trt. FGD: P/C + tank-based bio. Ash: P/C, recycle. Other: Enhanced Pond
8	Keep	Segregated trt. FGD: P/C + passive bio. Ash: P/C, recycle. Other: Enhanced Pond
9	Keep	Segregated trt. FGD: P/C + ZLD. Ash: P/C, recycle. Other: Enhanced Pond.
10	Note 1	Segregated trt. FGD: P/C + ZLD. Ash: P/C, recycle. Other: P/C.
~~11~~	Note 3	~~Segregated trt. FGD: P/C + ZLD. Ash: P/C, recycle. Other: P/C+tank-based bio~~
~~12~~	Note 3	~~Segregated trt. FGD: P/C + ZLD. Ash: P/C, recycle. Other: P/C+passive~~

TABLE 7
Initial Alternatives Evaluated – With Results of Screening Done October 2012 (“Overall Approach” Phase)

13	Keep	**Segregated trt. FGD: P/C + tank-based bio. Ash: P/C, discharge. Other: Enhanced Pond.**
14	Keep	**Segregated trt. FGD: P/C + passive bio. Ash: P/C, discharge. Other: Enhanced Pond.**
15	Keep	**Segregated trt. FGD: P/C + tank-based bio. Ash: pond, discharge. Other: Enhanced Pond.**
16	Keep	**Segregated trt. FGD: P/C + passive bio. Ash: pond, discharge. Other: Enhanced Pond.**
17	**Note 1**	**Segregated trt. FGD: P/C + tank-based bio. Ash: P/C, discharge. Other: P/C**
18	**Note 1**	**Segregated trt. FGD: P/C + passive bio. Ash: P/C, discharge. Other: P/C**
~~19~~	**Note 3**	~~**Segregated trt. FGD: P/C + tank-based bio. Ash: P/C, tank-based bio, discharge. Other: P/C+tank-based bio**~~
~~20~~	**Note 3**	~~**Segregated trt. FGD: P/C + passive bio. Ash: P/C, passive bio, discharge. Other: P/C+passive bio**~~
21	**Keep**	**Segregated trt. FGD: P/C + ZLD. Ash: P/C, discharge. Other: Enhanced Pond.**
22	**Note 1**	**Segregated trt. FGD: P/C + ZLD. Ash: P/C, discharge. Other: P/C**
~~23~~	**Note 3**	~~**Segregated trt. FGD: P/C + ZLD. Ash: P/C, discharge, tank-based bio. Other: P/C+tank-based bio**~~
~~24~~	**Note 3**	~~**Segregated trt. FGD: P/C + ZLD. Ash: P/C, discharge, passive bio. Other: P/C+tank-based bio**~~
~~25~~	**Note 2**	~~**Combined P/C for Ash and other. Tank-based P/C for FGD. Combined tank based biological**~~
~~26~~	**Note 2**	~~**Combined P/C for Ash and other. Tank-based P/C for FGD. Combined passive biological**~~
~~27~~	**Note 2**	~~**Combined enhanced pond for Ash and other. Tank-based P/C for FGD. Combined tank based biological**~~
~~28~~	**Note2**	~~**Combined enhanced pond for Ash and other. Tank-based P/C for FGD. Combined passive biological**~~
~~29~~	**Note 4**	~~**Combined enhanced pond for Ash and other. Pond for FGD. Combined tank-based biological**~~
~~30~~	**Note 4**	~~**Combined enhanced pond for Ash and other. Pond for FGD. Combined passive biological**~~
~~33~~	**Note 4**	~~**Combined enhanced pond for Ash and other. Pond for FGD. FGD tank-based biological**~~
~~34~~	**Note 4**	~~**Combined enhanced pond for Ash and other. Pond for FGD. FGD passive biological**~~
~~35~~	**Note 4**	~~**Recycle ash, enhanced pond for FGD, enhanced pond for other, combined tank-based biological**~~
~~36~~	**Note 4**	~~**Recycle ash, enhanced pond for FGD, enhanced pond for other, combined passive biological**~~
37	**Keep**	**Piping, outfall, permitting to move discharge to White River**

Notes:

1- Keep for now due to metals>limits in Other. Will re-evaluate when we have more data on the Other wastewater. And will evaluate if re-route demineralizer regenerant waste if rest of Other wastewater is < limits.

2- Eliminate because it is better to segregate FGD wastewater. High risk of ELG requiring compliance prior to co-mingling with other wastewater streams.

3- Eliminate because it appears biological treatment for Other wastewater is not needed; good likelihood of meeting limits with just Enhanced Ponds, which is a lower cost option.

4- Eliminate because of high compliance risk (mercury). Also, those options that did not have biological or ZLD treatment of FGD water were eliminated due to risk of non-compliance with selenium limit in NPDES permit, and in proposed ELG.

Alternatives Evaluation – Phase 2

The alternatives that remained after the first phase were further evaluated by refining designs and costs, evaluating various types of technology within some categories (such as types of biological treatment), and treatability testing of some technologies. The second phase of the alternatives evaluation included meetings on December 6, 2012 and January 15, 2013 in which some alternatives were screened out. Additional work was then done during 2013 to further narrow down to the selected compliance strategy.

Phase 2 Evaluation of FGD Water

It was determined in Phase 1 that ZLD or advanced biological treatment was required. This was driven by the fact that selenium in forced oxidation FGD systems is present as selenate (which is poorly removed by physical/chemical treatment) at levels representing a high compliance risk with the NPDES discharge limits on selenium, and high risk with the proposed ELG limit on selenium in FGD water. This resulted in the following alternatives remaining for evaluation in Phase 2:

- Physical/chemical treatment plus biological treatment using the GE ABMet process
- Physical/chemical treatment plus biological treatment using the FBR process (Note that MBBR was also evaluated, but was considered less-proven and similar cost to FBR so was screened out.)
- Physical/chemical treatment plus biological treatment using passive biological treatment
- ZVI
- “Near ZLD” in which thermal evaporator used, and brine disposed of as wetting agent for fly ash
- “Total ZLD” in which thermal evaporator and crystallizer used to produce solid salt cake for disposal

FGD Water – Selection of Preferred Biological Treatment Process

Biological treatment using ABMet reactors was selected for further consideration over passive biological, FBR, and ZVI because the other technologies had little or no full-scale application with FGD water. Also, ZVI showed ammonia formation in bench-testing of IPL FGD water (a non-compliance risk due to toxicity). This decision was made during the December 2012 team meeting. At that time, the cost comparison of the alternatives was as shown in **Table 8**.

The land required for anoxic, anaerobic and aerobic treatment was estimated to be a minimum of 18 acres for Harding Street for removal of selenium and nitrate sufficient to get selenium removal (including redundancy, separating berms and support equipment). Additionally, the proposed ELGs require an extremely low level of nitrate and nitrites. Passive biological treatment generates organic nitrogen compounds in excess of the low nitrate and nitrite limits proposed in the ELG, which may require additional active biological treatment after typical passive treatment systems, increasing cost and land area required considerably. Based on land requirements, and issues associated with nitrate and nitrite limits, passive treatment is considered a moderate-high risk of NPDES noncompliance (selenium final limit in NPDES permit) and therefore was not considered further.

TABLE 8
FGD Wastewater Biological Treatment Alternatives Evaluation in December 2012

Alternatives	Capital Costs for FGD Treatment	Annual O&M Costs for FGD Treatment	Risk Notes
Physical/Chemical + Passive biological	$46,000,000	$1,700,000	Used at two sites on FGD water, not proven to meet ELG limits
Zero Valent Iron (ZVI)	$49,000,000	$2,500,000	Not used on FGD water full-scale
Physical/Chemical + FBR biological	$59,000,000	$2,700,000	Not used on FGD water full-scale
Physical/Chemical + ABMet biological	$68,000,000	$2,600,000	A few full-scale applications on FGD water (this technology was used by EPA in setting BAT limits for FGD treatment in the proposed ELG)

FGD Water – Selection of Preferred ZLD Process

Sub-alternatives were developed for the ZLD treatment of FGD water: 'near ZLD' where an evaporator is used to reduce the wastewater to a brine that is mixed with ash and landfilled, and total ZLD where wastewater is reduced to a salt cake using an evaporator and crystallizer. 'Near ZLD' was chosen because of significantly lower cost than total ZLD, because there is adequate fly ash to use in disposal of the FGD ZLD brine, and because of concerns with operability of crystallizers on FGD water.

The ZLD option was refined during the project to include recycling a portion of the FGD water back to the FGD with just solids removal thereby reducing the size of the evaporator and softening. This lowered cost of this option. The flow of FGD system blowdown at both the Harding Street and Petersburg Stations is driven by fine solids content rather than chlorides. A "ZLD with Recycle" approach was developed in which FGD water blowdown is split into two streams. A portion of the FGD wastewater is treated by physical/chemical treatment (clarifier) and then recycled to the FGD system. A smaller portion of FGD wastewater is treated with softening and evaporation, producing two liquid streams:

- Evaporator distillate, which can be reused in the power plant (recycled to the FGD system, or may be used in other high purity uses in the power plant if the ELGs allow it)
- Evaporator brine to be mixed with fly ash and transported offsite for disposal in a landfill

Within the ZLD options, the "near ZLD" with recycle of some water back to the FGD was selected because of its lower cost compared to ZLD without recycle (see **Table 9**).

FGD Water – Selection between Physical/Chemical plus Biological Treatment versus ZLD

CH2M HILL recommends ZLD (specifically "near ZLD" with recycle) because it has lower overall risk and has comparable cost as ABMet biological tank-based treatment, as shown in **Table 9** and **Figure 1**. Specific issues that made this biological treatment option risks higher include:

- Water quality limits in NPDES permit. Discharging treated FGD water would increase risk of non-compliance compared to not discharging it (as would be the case in the ZLD option).
- Future water quality limits:
  - Although Outfall No. 006 does not currently have a limit for boron, the Harding Street Station has a monitor and report requirement, and a limit is highly probable in the future similar to the Boron limits contained in the Petersburg NPDES permit. The current monitoring data collected starting in October 2012 is above the calculated limit for discharge to the White River and there is a high risk of future

noncompliance with a boron limit if IPL pursues biological treatment and most cost spent on biological system could not be transferred to a ZLD system (technologies are two different systems with little overlapping parts).

- Future water quality based limits, such as salinity, may not be met with FGD water treated by biological treatment and then discharged.

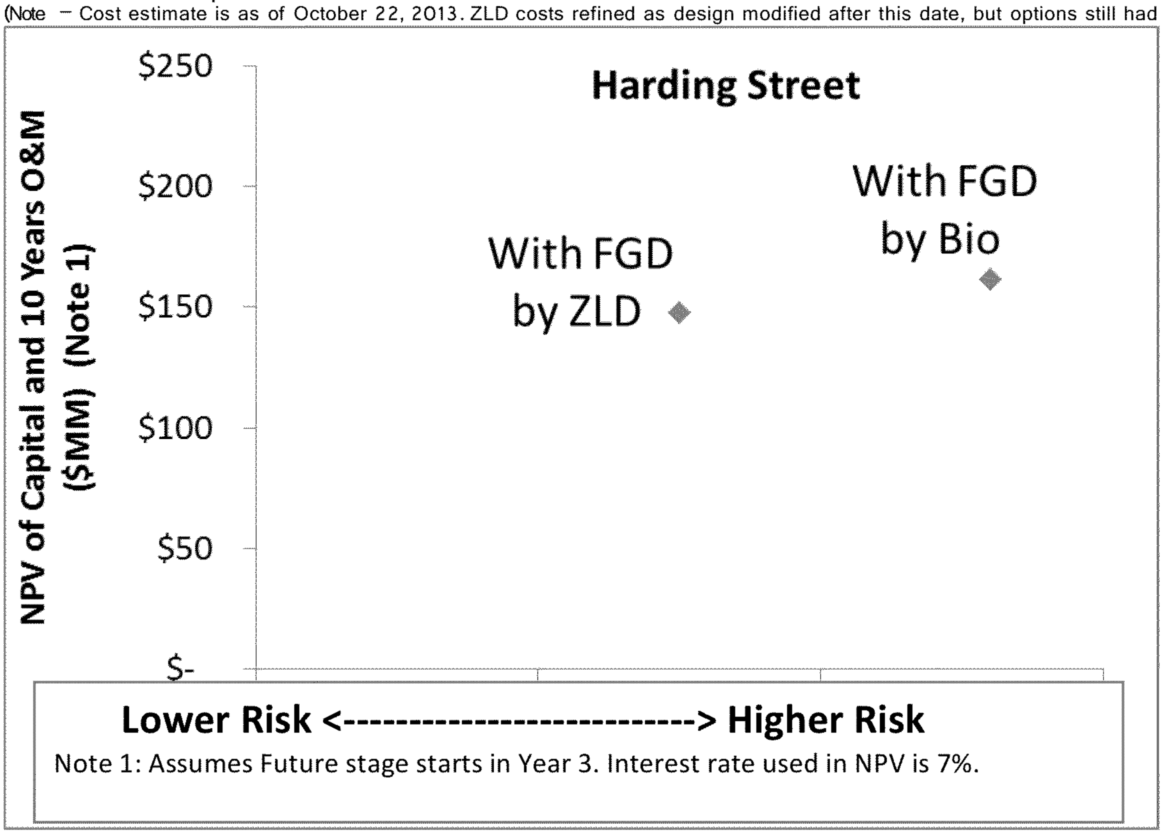
- Harding Street Station FGD water has higher level of nitrates and sulfates than most FGD water. The suitability for complying with NPDES limits using biological treatment cannot be assured without extensive pilot testing with Harding Street's wastewater.
- Biological treatment has risk that it will not meet future ELG limits, and would need to be replaced with ZLD. This represents a potential moderate-high risk of future regulation adaptability.
- There is risk that MATS will change the FGD wastewater chemistry, thereby affecting the levels of selenium and/or mercury removal that biological treatment can achieve which may result in a higher probability of non-compliance risk with the NPDES permit limits if using biological treatment.

TABLE 9
FGD Wastewater Treatment Alternatives Evaluation in October 2013

Alternatives	Capital Costs for Full Compliance Strategy*	Annual O&M Costs for Full Compliance Strategy*
FGD by physical/chemical plus biological treatment	$123,000,000	$4,800,000
FGD by ZLD; with recycle	$116,000,000	$4,000,000
FGD by ZLD; no recycle	$132,000,000	$6,200,000

*- This "full compliance strategy cost" comparison was done to isolate the FGD cost differences with a common assumption of dry fly ash handling, bottom ash water by physical treatment with recycle, and Other Water treated by enhanced pond. Note that this is not necessarily the final compliance strategy for bottom ash water or Other water.

FIGURE 1
FGD Wastewater Compliance Decision Grid
(Note – Cost estimate is as of October 22, 2013. ZLD costs refined as design modified after this date, but options still had comparable costs)



Phase 2 Evaluation of Ash Water

As was described in the Overall Approach section above, dry fly ash handling was selected as the recommended compliance strategy. This choice was made based on fly ash water's loading of pollutants regulated in the NPDES permit, and because it offered a lower risk and lower cost than treating the fly ash water to NPDES discharge limits either by itself or combined with other streams. Both IPL stations already have some infrastructure in place to handle ash dry, which assists in the elimination of wet fly ash handling. This leaves the need for a compliance strategy for bottom ash water. Early steps of the alternative evaluation screened out most options for these ash water leaving a selection between: tank-based physical treatment plus recycling, tank-based physical/chemical treatment plus discharge, or pond treatment with discharge.

Pond Treatment

Use of enhanced ponds (new, lined ponds) for bottom ash was considered in the early phases of the project. However, it was rejected as a risk of spending significant capital (tens of millions of dollars) on treatment that may later become obsolete. Therefore, the pond-treatment option became a consideration of continuing to use the existing ponds. This is the lowest-cost option.

If ponds are used, the water will need to be discharged rather than recycled. This is because the net increase in water into the system due to precipitation would necessitate some wastewater discharge. Also, if the bottom ash water is mixed with other, saltier water, the salts would build up and cause risk of scaling and corrosion.

As was shown in Table 4 and CSP Appendix E, discharge of bottom ash transport water has some compliance risk if treated in ponds. There was only one parameter in one sample out of four samples of soluble metals in bottom ash water greater than one-half the discharge limit. This was selenium, present just below the limit in one sample. Bottom ash does not typically leach much selenium. And Other Water should have lower selenium and help dilute selenium in the Bottom Ash Water, though this is hard to verify because Other Water data affected by regenerant waste and fly ash to Unit 7 sump. Therefore, discharging bottom ash water at Harding Street is considered to have low-to-moderate risk of selenium non-compliance until actual water from Unit 7 sump can prove how much selenium dilution there will be. It is problematic to predict selenium concentrations until the change to Unit 7 sump are made. Therefore, bottom ash water treatment needs to either have source elimination (i.e., closed loop) or some treatment. CH2M HILL recommends adding chemical feed and aeration to the existing ponds to help mitigate this risk, at a relatively low cost.

If ponds are used it is possible that they may need to be replaced later with tank-based treatment due to the potential CCR Rule requirements on ponds (to have liner, leachate collection, groundwater monitoring, etc.). It is also possible that discharge may need to be replaced with recycle if the final ELG bans discharge of bottom ash water. The time period of potential technology replacement will be driven by the timing and requirements of the CCR and ELG rules. Currently, the CCR rule is projected to be finalized in December 2014 and the ELG rule is projected to be finalized by the end of September 2015. The compliance schedules are uncertain, but currently anticipated 5 to 7 years from finalization of the CCR Rule, and during the next NPDES permit renewal for the ELG Rule. The "cost penalty" of changing from pond-based treatment to tank-based treatment is primarily the cost of doing two projects: more engineering, procurement, construction management, and contractor mobilization. The estimated risk cost is $1.3 million. This allows IPL to, at a minimum, delay additional cost until more certainty exists around the outcome and timing of potential future regulations.

Other considerations evaluated associated with the continued use of the existing ash pond system for bottom ash treatment included:

- Groundwater. Continuing to treat bottom ash water in the pond system, and enhancing the removal of trace pollutants (such as mercury) by chemical precipitation, may have more impact on groundwater underlying the pond then stopping the use of the existing pond system and instead treating bottom ash water in tank-based treatment. It is CH2M HILL's opinion that there is very minimal (if any) risk that the proposed treatment chemicals (polymer and organosulfide) would migrate into groundwater in detectable quantities (if at all). The chemicals will be added at part-per-million levels, and should be bound to solids that then stay in the pond.
- Limited data to assess risk. It should be noted that the water quality data used to assess non-compliance risk (Table 4) is limited, with only a few samples of bottom ash water.
- Compliance risk of discharging bottom ash. If bottom ash water is treated in a tank-based system and then recycled and FGD water is treated in a ZLD system, the only discharge to Outfall No. 006 will be the Other Water, which is treated in a new enhanced pond. If bottom ash is managed in existing ash ponds and discharged, Outfall No. 006 will receive a mixture of the bottom ash water and the Other Water. Bottom ash water discharge via existing ash ponds, with new chemical and aeration addition, and then mixing with Other Water (treated in its own enhanced pond) should reduce the overall risk of non-compliance versus Other Water discharge alone. This is because bottom ash water after chemical and aeration addition and settling in the pond should be lower in regulated parameters than Other Water. This is based on the limited IPL data set, as well as data and CH2M HILL experience at other power plants. However, the bottom ash water discharge via ponds will likely have some increase to risk on occasion – namely when dredging, wind-blown pond turbulence, or other solids-disturbing event causes increased solids carryover from the pond.

Tank-Based Treatment

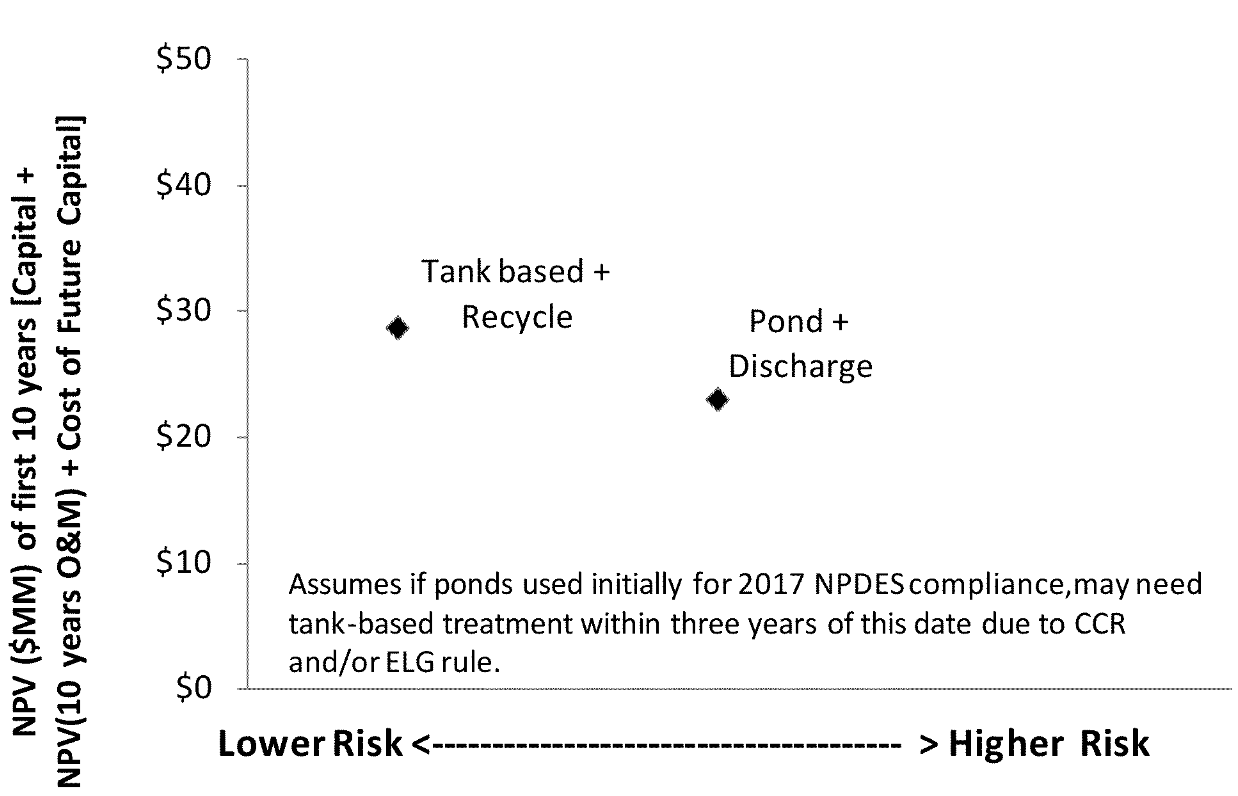
In considering tank-based treatment, the project team chose recycle over discharge because discharge would be similar or higher cost due to need for additional treatment to remove fine solids. Recycle requires more pumping and piping, while discharge would require a secondary clarifier added to treatment system to meet suspended solids limits. Recycle was also preferred because recycling will eliminate potential risk of discharge non-compliance with the current NPDES permit, and because recycling also eliminates the potential risk of having to change wastewater management to comply with the final ELGs, which may ban discharge of bottom ash transport water.

Compliance Strategy Recommendation

In conclusion, continued treatment in ash ponds, with addition of chemical feed and aeration to mitigate risk of non-compliance was chosen as the recommended compliance strategy because of lower initial capital cost at low probability of non-compliance risk.

The cost comparison of pond treatment versus tank-based treatment with recycle is shown in **Appendix E** and **Figure 2**.

FIGURE 2
Relative Risk of Non-Compliance with Current Limits and Costs -- Ash Water Options



Phase 2 Evaluation of Other Water

Early steps of the alternative evaluation screened out most options for Other Water because they were believed to provide more treatment than needed in order to achieve compliance, leaving two alternatives to select between for Other water: treatment by tank-based physical/chemical treatment or enhanced pond treatment.

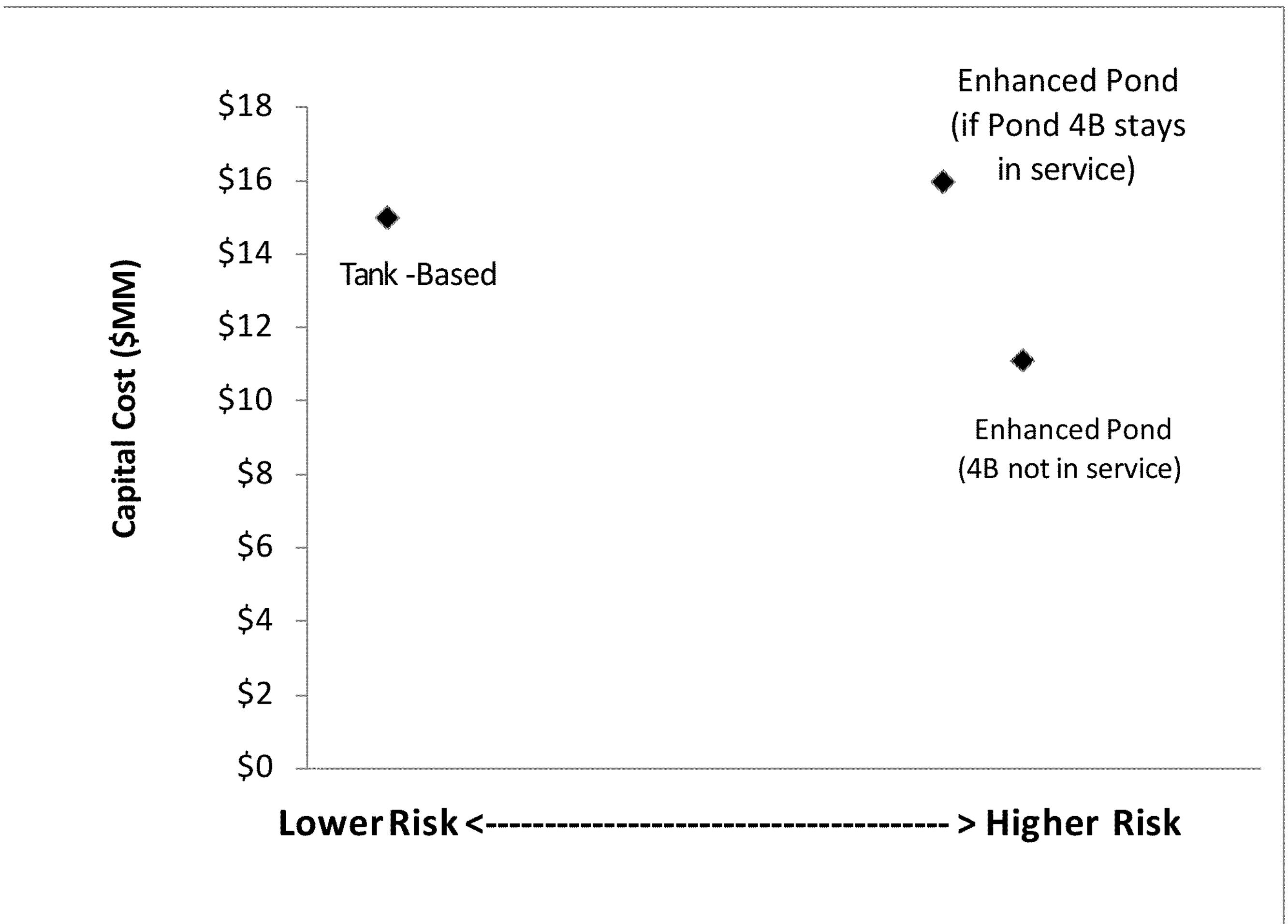
Early cost estimates (2012) showed pond-based treatment to be much lower cost. But as more information was obtained in 2013 on the geotechnical conditions of the ash pond, the cost estimates for tank-based and pond based became cost competitive due to the cost of preparing Pond 4 and 4B to build the enhanced pond on Pond 4. Taking Pond 4B out of service introduces a medium to high risk of non-compliance, as it would remove a significant percent of the ash pond system. This is shown in Table 10 and Figure 3.

TABLE 10
Other Wastewater Treatment Alternatives Evaluation

Alternatives	Capital Costs for Just the Other Water System ($ millions)	Annual O&M Costs for Just the Other Water System
Other Water by new Tank-based Treatment	$15	O&M costs are roughly equal between options
Other Water by new Enhanced Pond - If Pond 4B stays in service	$16 [1]	
Other Water by new Enhanced Pond - - If Pond 4B does not stay in service	$11 [1]	

[1]- Cost estimates for pond-based treatment do not include additional pond system components IDEM explained in April 2014 meeting would be needed. If included, the cost of enhanced ponds would increase.

FIGURE 3
Relative Risk of Non-Compliance with Current Limits and Costs -- Other Water Options
Operating Costs are similar so only Capital Costs are shown
Cost estimates for pond-based treatment do not include additional pond system components IDEM explained in April 2014 meeting would be needed. If included, the cost of enhanced ponds would increase.



Due to land restrictions at the facility, there is no room to build the enhanced pond other than on top of retired ash pond unit(s). The cost of preparing Pond 4 for construction of an enhanced pond is higher if Pond 4B needs to be kept in service. If 4B is taken out of service there would be higher risk of solids carry-through and non-compliance. This risk may be reduced by adding treatment chemicals and increased dredging of both pond units.

Risks associated with enhanced pond treatment include:

- There is less cost certainty at this time because additional geotechnical information and the chosen means of construction could significantly increase or decrease costs from CH2M HILL's cost estimate based on preliminary information. EPC bids will be required to improve cost certainty.
- One potential advantage of building an enhanced pond on an out-of-service ash pond is that the new pond's underlying liner would form a portion of the closure of the former pond. However, there is a moderate-to-high risk of not getting such a closure plan approved within the timeframe that this NPDES wastewater system is needed and in the same design concept as proposed.
- There is a moderate probability of risk that the final CCR Rule will prohibit the use of ponds and/or contain location restrictions which may drive pond closure. If this occurs, the ponds would need to be replaced with tank-based treatment. However, if ponds only contain non-CCR wastestreams, then the probability of risk may be reduced if the final rule does not regulate these type of non-CCR surface impoundments. The compliance plan is for bottom ash tank overflow wastewater (seal water) to flow to Other Water group. Because this water contains bottom ash, this may be determined to meet the definition of bottom ash transport water under the final ELGs and require this seal trough water be managed with Ash Water.
- Pond-based treatment offers less treatment for mercury and other metals than tank-based. In some samples collected from the Unit 7 Waste sump, elevated concentrations of some metals were detected. The Unit 7 Waste sump receives wastewater from multiple sources including ash hopper overflow, demineralizer system flows, and area drains. It is believed that ash is sometimes a component of the wastewater streams that enter the sump. When the demineralizer systems discharge regeneration streams to the sump, metals from the ash are mobilized creating higher concentrations of metals. These concentrations are potentially greater than those that would typically be applied to pond-based treatment. This risk may be mitigated by replacing the current demineralizer ion exchange beds and reverse osmosis (RO) system with a new reverse osmosis system with mixed-bed polishing and self-neutralization. The current demineralizer practice consists of alternating regeneration with strong acids and bases. As a result, the pH in the sump alternates between acidic and alkaline conditions. Alkaline pH dissolves anionic metals such as arsenic and selenium. Acidic pH dissolves cationic metals such as mercury. The result is that these metals from flyash present in the Unit 7 Waste sump are dissolved during demineralizer regeneration. Adding a RO may reduce the need for regeneration chemicals. It is recommended that the design of a potentially new system include a sufficiently large neutralization tank volume such that the regenerant solutions would neutralize each other before discharge to the Unit 7 Waste sump. Reducing the pH swings through this self-neutralization may reduce the leaching of metals from fly ash present in the sump. The addition of a RO system is recommended for both enhanced pond and tank-based treatment options.

Based on our understanding of costs and risks, CH2M HILL recommends that tank-based treatment is the best approach to address this treatment need.

Evaluation of Wastewater Compliance if Units 5, 6, and 7 Converted to Natural Gas Fired

A wastewater compliance concept was developed for a scenario in which Harding Street's Units 5, 6, and 7 were converted to natural gas. If coal use ended and the units were gas-fired, the FGD and Ash water groups would be eliminated. The Other Water group would remain. The basis of design flow was estimated to be the same roughly 1,800 gpm as in the coal-fired scenario described above. It should be noted that Units 5 and 6 cooling is essentially once-through and is not included in the design basis for the proposed new tank-based treatment.

The wastewater produced from Harding Street if converted to natural gas will require treatment to ensure compliance with the NPDES permit limits on TSS and mercury. The primary driver of treatment system equipment and cost will be TSS. Cooling tower blowdown (the source of most the wastewater in a gas-fired Harding Street scenario) concentrates the TSS in the river water by the number of cycles of concentration the tower performs at. This can result, especially during rain events when the river has high TSS, in cooling tower blowdown in the hundreds of mg/L. The monthly average limit is 30 mg/L TSS. Also, cooling tower blowdown exceedances of mercury, due to concentrating up the mercury in the river water, is considered a moderate-high risk. Therefore, treatment is required for TSS, and likely for mercury. A treatment system built for solids removal includes clarifier, chemical mix tanks, and sludge dewatering. Adding mercury removal with organosulfide feed adds little to the capital costs. If future water quality results show that metals treatment is not needed, then operating costs could be reduced (by buying less organosulfide).

This compliance scenario would include:

- A wastewater collection system of sumps, pumps, and pipes to transfer wastewaters from their points of generation to the treatment facilities.
- Treatment of “Other Water” streams with tank-based physical/chemical treatment. This treatment would include chemical addition to help remove trace metals such as mercury.

The tank-based treatment system would include two parallel treatment trains, each sized to treat 75 percent of the peak design flow. The system would include chemical mix tanks and a clarifier to settle out solids. The system would also include filter presses to dewater solids removed in the clarifier. It is assumed that the system would be near the power block, and make use of some tanks and buildings that would no longer be needed for their original purpose once coal firing stopped.

A rough cost estimate for this concept is $23,000,000 capital cost (which includes $3,000,000 of estimating contingency), and $600,000/year annual operating cost. This estimate is considered a Class 4 cost estimate.

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Estimated Capital Cost

CLIENT: Indianapolis Power & Light Company (IPL)
LOCATION: Harding Street Generating Station
OPTION: Conversion of Units 5, 6, and 7 to Natural Gas

Item	Value	Units	No. Provided	Equipment Unit Cost ($ ea)	Equipment Amount	Installation ($ ea)	Total Installed Cost ($)
Lift Tank (Existing - Make Up Water Tank)	3000	gal	1	0	0	10,000	8,470
Hypothetical Lift Tank Costs (for use in Construction, Indirects, & Escalation Costs)				*13,745*	*13,745*		*13,745*
Lift Tank Pumps	2000	gpm	2	84,090	168,181	24,297	209,340
Equalization Tanks (Existing - Gypsum Slurry Filter Feed Tanks)	571,200	gal	2	0	0	30,000	50,820
Hypothetical EQ Tank Costs (for use in Construction, Indirects, & Escalation Costs)				*394,647*	*789,294*		*789,294*
Equalization Tank Agitators (Existing 100 HP Agitators)	100	HP	2	0	0	30,000	50,820
Hypothetical EQ Tank Agitators Costs (for use in Construction, Indirects, & Escalation Costs)				*145,924*	*291,848*		*291,848*
Mix Tank Feed Pumps	1,800	gpm	2	76,101	152,202	13,913	175,770
Mix Tanks	16,000	gal	2	37,527	75,053	7,505	87,767
Mix Tank Agitators	2	HP	2	42,232	84,465	1,817	87,543
Clarifiers	75	ft diameter	2	575,392	1,150,784	28,396	1,198,887
Clarifier Sludge Pumps	200	gpm	4	77,528	310,112	4,255	324,527
Sludge Storage Tank (Existing)	463,000	gal	1	0	0	40,000	33,880
Hypothetical Sludge Storage Tank Costs (for use in Construction, Indirects, & Escalation Costs)				*347,924*	*347,924*		*347,924*
Sludge Tank Agitator (Existing)	50	HP	1	0	0	15,000	12,705
Hypothetical Sludge Tank Agitators Costs (for use in Construction, Indirects, & Escalation Costs)				*93,289*	*93,289*		*93,289*
Filter Press	50	cf	1	129,501	129,501	49,666	171,568
Filter Press Feed Pump	150	gpm	2	94,524	189,048	6,253	199,641
Service Water Pump	300	gpm	2	16,182	32,364	4,167	39,423
Polymer Blending System	1	gph	3	25,000	75,000	2,550	81,480
Organosulfide Metering Pump	2	gph	3	12,000	36,000	2,100	41,336
Ferric Chloride Tank	6,000	gal	1	37,600	37,600	8,580	44,867
Ferric Chloride Metering Pump	5	gph	3	12,000	36,000	2,100	41,336
Caustic Metering Pump	4	gph	3	12,000	36,000	2,100	41,336
Area Labor Adjustment Factor	84.7%	applies to installation cost only			2,512,000		
Total Equipment Cost (TEC)							**2,512,000**
Hypothetical Total Equipment Cost (TEC) including existing equipment							*4,048,000*
Total Construction Material					3,471,500		
Freight	4%	of Proc Equip					100,000
State Sales Tax	1.0%	of Material					60,000
Purchased Equipment Cost - Delivered (PEC-D)							**2,672,000**
Hypothetical Purchased Equipment Cost - Delivered (PEC-D) including existing equipment							*4,208,000*
Process & Yard Piping Demolition	1	LS					125,000
Electrical Duct Bank & Piping Relocation	1	LS					100,000
Pipe Racks	1	LS					150,000
Elevated Metal Platforms	1	LS					200,000
Cut-out Demolition & New Equipment Foundations	1	LS					300,000
New Containment Trenches & Sumps	1	LS					150,000
Building Modifications	1	LS					75,000
Fire Protection	1	LS					150,000
Control Room Modifications	1	LS					300,000
Clarifier Tunnel & Pipe Gallery	1	LS					500,000
Bridge Crane Modification	1	LS					50,000
Influent Wastewater Connection	1	LS					150,000
Effluent Wastewater Connection & Outfall	1	LS					300,000
Mezzanine for Filter Press in the Existing Building	1	LS					100,000

Item	Value	Units	No. Provided	Equipment Unit Cost ($ ea)	Equipment Amount	Installation ($ ea)	Total Installed Cost ($)
Auger Cast Piles for WWTP	13,050	linear feet				$110.00	1,436,000
Installation Costs							390,000
Process Piping	20%	of PEC-D					842,000
Yard Piping	3%	of PEC-D					126,000
Instrumentation and Controls	12%	of PEC-D					505,000
Electrical	40%	of PEC-D					1,683,000
Yard Improvements (a)	3%	of PEC-D					126,000
Metals and Finishes	5%	of PEC-D					210,000
Subtotal							10,640,000
Total Direct Costs							**10,640,000**
Hypothetical Total Direct Costs (TDC), which adds the cost needed if existing equipment was not available							*12,176,000*
Contractor's Field General Conditions	10%	of TDC					1,218,000
Contractor's OH&P	15%	of TDC					1,826,000
Escalation Factor	12%	of TDC					1,408,000
Subtotal Indirects and Escalation							**4,452,000**
Subtotal Construction, Indirects, and Escalation							**15,092,000**
Hypothetical Subtotal Construction, Indirects, and Escalation including existing equipment							*16,628,000*
EPC - Engineering and Procurement	15%						2,494,000
EPC - Construction Permits & Testing	2%						333,000
EPC - Startup	4%						665,000
Copper and Iron Treatment		Total Installed Cost					525,000
Subtotal EPC - Engineering, Startup, Permitting and Testing							**4,017,000**
					High Range +50%	**Base Bid**	**Low Range -30%**
Total Construction - EPC Cost (TCC) without Estimating Contingency (b) (f)					28,664,000	**19,109,000**	13,376,000
Total Construction - EPC Cost (TCC) <u>with</u> Estimating Contingency (b) (f)	30%		3,192,000		33,452,000	**22,301,000**	15,611,000
Other Project Related Costs							
Stormwater Activities (c)		Total Installed Cost					695,000
Subtotal Project Related Costs							**695,000**
					High Range +50%	**Base Bid**	**Low Range -30%**
Total Estimated Order of Magnitude Capital Cost with Other Project Costs but without Estimating Contingency (d) (e) (f)					29,706,000	**19,804,000**	13,863,000
Total Estimated Order of Magnitude Capital Cost with Estimating Contingency and Other Project Costs (d) (e) (f)					34,494,000	**22,996,000**	16,097,000

(a) Includes fencing, grading, roads, sidewalks, and similar items.
(b) The enclosed Engineer's Estimate is only an estimate of possible construction costs. This estimate is limited to the conditions existing at its issuance and is not a guarantee of actual price or cost. Uncertain market conditions such as, but not limited to: local labor or contractor availability, wages, other work, material market fluctuations, price escalations, force majeure events, and developing bidding conditions etc may affect the accuracy of this estimate. CH2M Hill is not responsible for any variance from this estimate or actual prices and conditions obtained.
(c) Not included in the EPC project.
(d) Cost estimate is considered a Class IV estimate (per Association for the Advancement of Cost Engineering International definition) with accuracy of +50/-30%.
(e) Does not include Owner's Costs
(f) Estimating Contingency: (1) An amount added to an estimate to allow for items, conditions, or events for which the state, occurrence, or effect is uncertain and that experience shows will likely result, in aggregate, in additional costs. Typically estimated using statistical analysis or judgment based on past asset or project experience. Contingency usually <u>excludes</u>: 1) Major scope changes such as changes in end product specification, capacities, building sizes, and location of the asset or project; 2) Extraordinary events such as major strikes and natural disasters; 3) Management reserves; and 4) Escalation and currency effects. Some of the items, conditions, or events for which the state, occurrence, and/or effect is uncertain include, but are not limited to, planning and estimating errors and omissions, minor price fluctuations (other than general escalation), design developments and changes within the scope, and variations in market and environmental conditions. Contingency is generally included in most estimates, and is expected to be expended.

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Annual O&M Cost

CLIENT: Indianapolis Power & Light Company (IPL)
LOCATION: Harding Street Generating Station
OPTION: Conversion of Units 5, 6, and 7 to Natural Gas

Item	Quantity	Units	Unit Cost	Cost
Labor	6,240	hours	$ 30	$ 187,200
Maintenance (% of Purchased Equipment Cost)	4,208,000	$	3%	$ 126,240
Energy	1,200	MW-Hr	$ 100	$ 120,000
Waste Solids Disposal	120	tons	$ 32	$ 3,834
Chemicals				
Ferric Chloride	14,412	gallons	$ 1.66	$ 23,856
Sodium Hydroxide	11,277	gallons	$ 2.20	$ 24,810
Organosulfide	6,107	gallons	$ 20.00	$ 122,135
Polymer	1,441	gallons	$ 7.96	$ 11,473
Total Annual O&M				**$ 620,000**
NPV (rounded) - without contingency				**$ 24,000,000**
NPV (rounded) - with contingency				**$ 27,000,000**

*Increase in annual cost due to changes in wastewater management from current practices

Assumptions:

Rate of return, i = **8.25%**
Period = **10 years** **(max 25 yrs)**
Total Installed Cost (without contingency)= $19,804,000
Total Installed Cost (with contingency)= $22,996,000
Annual O&M Estimate = $620,000

Factor to account for the plant not operating at full capacity 30%

Appendix C
Petersburg Station
Compliance Alternative Evaluation

DRAFT TECHNICAL MEMORANDUM CH2MHILL®

Indianapolis Power & Light Company (IPL) - Petersburg – Effluent Metals Wastewater Treatment Study - Design Basis and Alternative Selection

PREPARED FOR:	David Kehres/IPL Nysa Hogue/IPL David Heger/IPL
PREPARED BY:	CH2M HILL
DATE:	Phase 1 Draft: November 9, 2012 Phase 2 Draft: January 4, 2013 Revised with most recent version of CSP

Introduction

CH2M HILL evaluated options for compliance with new National Pollutant Discharge Elimination System (NPDES) permit limits for Outfall No. 001 for IPL's Petersburg Station. Evaluation of compliance with NPDES permit limits at Outfall No. 007 are addressed in a separate memo (**Appendix D**). This technical memorandum (TM) presents a summary of the project's design basis and the alternative evaluation process. The alternatives were narrowed down to the selected compliance strategy in phases. In each phase, treatment costs were estimated to aid in decision making. After each phase, the number of alternatives were refined. It should be noted that costs for each alternative changed through the process as the designs were refined. These changes did not affect the decisions made in earlier phases.

Overall Approach

The current wastewater management approach at both stations is to co-manage process wastewater (other than once-through cooling water) in pond-based treatment. After determining that the current wastewater management approach, including the discharge of individual or combined streams, is not adequate to meet the new NPDES permit limits, CH2M HILL considered whether wastewater streams should be treated combined or segregated, and which streams should be managed by source control rather than treated.

It was determined that the process wastewaters should be separated into three wastewater groups: 1) FGD water, 2) ash transport water, 3) other wastewaters. The water flowing to Outfall No. 007 is a fourth group, and is discussed in a separate memo. The team also determined that fly ash water should be eliminated rather than treated. This approach was chosen because:

- **FGD water** is recommended for segregated treatment because FGD water is a concentrated, lower-flow source of several of the trace metals that have NPDES permit limits, treating it separately represents an opportunity for lower-flow and therefore lower cost treatment.
- **Fly ash.** The team determined that fly ash water should be managed separately, as it is source of pollutants with NPDES discharge limits. The options available include: elimination of wet fly ash handling, continued treatment in ponds, building tank-based treatment, and closed-loop reuse of fly ash water.
  - Treatment in ponds was eliminated because of high risk of non-compliance with NPDES discharge limits (especially selenium and mercury).
  - Reuse of fly ash water was not recommended because fly ash contributes anions to water (such as chlorides and sulfate) represent a high operability risk due to scaling and corrosion.

  - Dry fly ash handling was chosen rather than tank-based treatment because it offered a lower risk and lower cost than treating the fly ash water to NPDES discharge limits either by itself or combined with other streams. Both IPL stations already have some infrastructure in place to handle ash dry, which assists in the elimination of wet fly ash handling. Dry fly ash handling also eliminates the risk that changes due to MATS compliance (such as carbon injection) will change the fly ash water making it harder to treat to compliance.

- **Bottom Ash and Other wastewater** streams are recommended to be treated separately from each other. Segregation of bottom ash water from Other water is recommended as it will allow the bottom ash water to be reused (if desired now or in future) since it is lower in corrosive salts than the remaining wastewaters (which have significant concentration of salts from cooling tower blowdown and source water treatment residuals). The remaining wastewaters (i.e., non-CCR containing water) can be managed and treated with fewer regulatory requirements than if ash-containing (CCR) water is included.

Design Basis

The design basis for evaluating overall approach options consists of: wastewater flow, wastewater quality, and discharge limits.

Effluent Water Quality Limits

Effluent Water Quality Limits - Current Permit for Discharge to Lick Creek

The current permit's effluent water quality limits are shown in **Table 1**.

TABLE 1

Petersburg Generating Station NPDES Permit Limits for Outfall Nos. 001 (Ash Pond System Discharge), 007 (FGD Sludge Disposal Site Runoff), and 111 and 112 (FGD Discharges)[1]

		Outfall No. 001 (Ash Pond)[1]			Outfall No. 007 (FGD Sludge Disposal Site Runoff)[1]		
Parameter	**Units**	**Effective Date[3]**	**Monthly Average**	**Daily Maximum**	**Effective Date[3]**	**Monthly Average**	**Daily Maximum**
Boron[2]	mg/L	Oct. 2012	Report	Report	Final (Sep. 2017)	8.3	14.0
Cadmium[2]	mg/L	Final (Sep. 2017)	0.002	0.0035	Final (Sep. 2017)	0.002	0.0035
Chromium[2]	mg/L	Oct. 2012	0.19	0.19	Oct. 2012	Report	Report
Copper[2]	mg/L	Interim (Oct. 2012)	0.2	0.2	Oct. 2012	Report	Report
	mg/L	Final (Sep. 2017)	0.022	0.039		--	--
Iron[2]	mg/L	Oct. 2012	1	1	Oct. 2012	Report	Report
Lead[2]	mg/L	Final (Sep. 2017)	0.0085	0.015	Final (Sep. 2017)	0.0085	0.015
Mercury[2]	ng/L	Final (Sep. 2017)	12	20	Final (Sep. 2017)	12	20
Nickel[2]	mg/L	Final (Sep. 2017)	0.1	0.24	Oct. 2012	Report	Report
O&G	mg/L	Oct. 2012	9	13	Oct. 2012	15.0	20.0
pH	S.U.	Oct. 2012	--	6.0 to 9.0	Oct. 2012	--	6.0 to 9.0
Selenium[2]	mg/L	Final (Sep. 2017)	0.033	0.057	Final (Sep. 2017)	0.033	0.057
TSS	mg/L	Oct. 2012	29	95	Oct. 2012	30.0	100.0
Sulfate	mg/L	Final (Sep. 2017)	1500	2600	Final (Sep. 2017)	1500	2600
Zinc[2]	mg/L	Interim (Oct. 2012)	0.95	0.95	Oct. 2012	Report	Report
	mg/L	Final (Sep. 2017)	0.20	0.35		--	--
TRC	mg/L	Interim (Oct. 2012)	0.13	0.2		--	--
	mg/L	Final (Oct. 2013)	0.01 [4]	0.02 [4]		--	--

Notes:

[1] Outfall No. 001 has report-only requirements for ammonia as N, arsenic, boron, BOD, cadmium (interim), chlorides, cyanide, flow, fluoride, lead (interim), manganese, mercury (interim), nickel (interim), phosphorus, selenium (interim), sulfate (interim), and TDS.

Outfall No. 007 has report-only requirements for ammonia as N, arsenic, boron (interim), BOD, cadmium (interim), chlorides, chromium, copper, cyanide, flow, fluoride, iron, lead (interim), manganese, mercury (interim), nickel, phosphorus, selenium (interim), sulfate (interim), TDS, and zinc.

Outfall Nos. 111 and 112 (FGD), not shown, have report-only requirements for ammonia as N, arsenic, boron, BOD, cadmium, chlorides, chromium, copper, flow, iron, lead, manganese, mercury, nickel, oil & grease, pH, phosphorus, selenium, TDS, TSS, thallium, and zinc. The report requirements take effect on the date of permit issuance.

[2] The identified metals are as total recoverable.

[3] The NPDES Permit requires compliance with the final permit limits for Outfall Nos. 001 and 007 no later than October 1, 2015, which was extended to September 29, 2017, in the AO for Case No. 2013-21497-W. Interim limits apply until the final limits become effective.

[4] The Final total residual chlorine (TRC) limit on Outfall No. 001 takes effect twelve months from the permit effective date.

ng/L = nanograms per liter

Effluent Water Quality Limits - Effect of Moving Discharge to White River

Relocating discharge from Lick Creek to the White River may allow higher water quality-based limits, and require treatment of fewer parameters to ensure compliance than if discharge is to Lick Creek. This is discussed further in the CSP **Appendix A**.

Flow

Peak daily flow, expressed in gallons per minute, will be used to size treatment systems in this evaluation. Flow estimates used in this evaluation are shown in **Table 2**.

TABLE 2
Flow Basis of Design for Petersburg Station Outfall Nos. 001 and 007

Wastewater Source	Category	Peak Day Average Flow (gpm)	Source	Comments
Coal Pile Runoff	Other	70	GE Flow Model	
Water Treatment and Boiler Blowdown	Other	264	GE Flow Model	
Seal Water Treatment Backwash	Other	20	GE Flow Model	
Boiler Ash Seal Water	TBD	2,000	Personnel Interview and Design Drawings	Included in Ash as well. See Note 1.
Cooling Tower 1	Other	600	Estimated based on MW	Assumes CT added to Unit 1
Cooling Tower 2	Other	1,100	Estimated based on MW	Assumes CT capacity increased
Cooling Tower 3	Other	1,280	GE Flow Model	
Cooling Tower 4	Other	1,280	GE Flow Model	
Demineralizer Waste Pump	Other	20	Plant Water Balance	
Oily Waste/Sewage Treatment /Seal	Other	155	GE Flow Model	15 gpm sanitary, 140 gpm seal water. Sanitary designed for 9 gpm.
Coal loading dust collector	Other	48		
Landfill runoff	Other	0		Estimated based on DMRs
Subtotal – Other Water		**6,837**		
Unit 1 Air Preheater Ash	Ash	69	Personnel Interview and Design Drawings	
Unit 1 Economizer	Ash	101	Personnel Interview and Design Drawings	Pulled 3x per shift for 5-minutes, 3-shifts per day
Unit 1 Bottom Ash	Ash	294	Personnel Interview and Design Drawings	Pulled 1x per shift for 30-minutes, 3-shifts per day
Unit 2 Air Preheater Ash	Ash	113	Personnel Interview and Design Drawings	Continuously pulled unless Bottom or Economizer ash are being pulled
Unit 2 Economizer Ash	Ash	113	Personnel Interview and Design Drawings	Pulled 2x per shift for 1-hour, 3-shifts per day
Unit 2 Bottom Ash	Ash	1,133	Personnel Interview and Design Drawings	Pulled 1x per shift for 1-hour, 3-shifts per day
Unit 3 Economizer Ash	Ash	770	Personnel Interview and Design Drawings	Pulled 3x per shift for 5-minutes, 3-shifts per day

TABLE 2
Flow Basis of Design for Petersburg Station Outfall Nos. 001 and 007

Wastewater Source	Category	Peak Day Average Flow (gpm)	Source	Comments
Unit 3 Bottom Ash	Ash	1,176	Personnel Interview and Design Drawings	Pulled 2x per shift for 2-hours, 3-shifts per day
Unit 4 Economizer Ash	Ash	734	Personnel Interview and Design Drawings	Pulled 3x per shift for 5-minutes, 3-shifts per day
Unit 4 Bottom Ash	Ash	1,397	Personnel Interview and Design Drawings	Pulled 2x per shift for 2-hours, 3-shifts per day
Unit 7 Boiler Ash Seal Water (“Ash Seal Trough”)	TBD	2,000	Personnel interview	Included in Other as well. See Note 1.
Subtotal – Ash Water		**7,899**		
IUCS/dewatering seal water	Other	220	Personnel Interview	Mixed with FGD waters
Subtotal - FGD reclaim recycle system		**220**		
IUCS Process	FGD	70	Personnel Interview	
Gypsum Sump	FGD	85	Personnel Interview	Includes filtrate, wash water, and area sumps
Unit 1 Primary Hydrocyclone Overflow	FGD	40	Personnel Interview	
Unit 1 Secondary Hydrocyclone Overflow	FGD	0	Personnel Interview	No discharge from secondary hydrocylone to ash pond typically
Unit 2 Primary Hydrocyclone Overflow	FGD	60	Personnel Interview	
Unit 2 Secondary Hydrocyclone Overflow	FGD	0	Personnel Interview	No discharge from secondary hydrocylone to ash pond typically
Unit 4 Secondary Hydrocyclone Overflow- Surge Tank	FGD	392	Personnel Interview	1175 gpm pump capacity, discharges water to ash pond for 10 minutes out of every 30 minutes.
Subtotal – FGD Water		**647**		

Notes:
[1] Boiler seal water included in both Other water and Ash water groups. EPC bid specification base case will not include this flow in Ash Water, and will ask for optional pricing with it included in Ash Water.
IUCS = Illinois University Conversion System

Water Quality

To evaluate which pollutants would need to be removed to meet discharge limits, CH2M HILL compared available water quality data to the permit limits. This is shown in **Tables 3 and 4**. Discharge monitoring report (DMR) data were evaluated against permit limits to identify parameters needing treatment initially. This comparison indicates parameters that require treatment per the NPDES permit’s final limits. This analysis indicates that for Outfall No. 001, treatment for mercury, cadmium, selenium, iron, TRC, and sulfate likely would be required. And for Outfall No. 007, treatment or source control for boron, sulfate and mercury may be required. Wastewater management alternatives were developed by first evaluating which wastewater streams were causing the regulated plant outfalls to have metals loading above the current limits. This evaluation showed that treatment is needed, and identified which streams required treatment for which metals, as shown in **Table 5**.

TABLE 3
Pollutants with Numeric Limits in October 2012 NPDES Permit – Petersburg Outfall No. 001
Monitoring Data from January 2009 to December 2013

Parameter	Units	NPDES Permit Limits			Historical Monitoring		% of Samples Above Daily Limit	% of Samples Above Monthly Average Limit
		Effective Date	Monthly Avg	Daily Max	Avg	Max	%	%
Cadmium	mg/L	Sep. 2017	0.002	0.0035	0.005[1]	0.011	46%	75%[1]
Chromium	mg/L	Oct. 2012	0.19	0.19	0.006[1]	0.011	0%	0%
Copper	mg/L	Sep. 2017	0.022	0.039	0.012[1]	0.06	2%	30%[1]
Iron	mg/L	Oct. 2012	1.0	1.0	0.49	2.0	7%	7%
Lead	mg/L	Sep. 2017	0.0085	0.015	0.005[1]	0.01	0%	7%[1]
Mercury	ng/L	Sep. 2017	12	20	223	490	100%	100%
Nickel	mg/L	Sep. 2017	0.1	0.24	0.06	0.14	0%	4%
Oil & Grease	mg/L	Oct. 2012	9	13	2.6[1]	6.4	0%	0%
pH	s.u.	Oct. 2012	--	6.0 to 9.0	--	6.1 to 8.0	0%	0%
Selenium	mg/L	Sep. 2017	0.033	0.057	0.086	0.14	76%	100%
TSS	mg/L	Oct. 2012	29	95	18	68	0%	0%
Sulfate	mg/L	Sep. 2017	1500	2600	1420	1900	0%	45%
Zinc	mg/L	Sep. 2017	0.20	0.35	0.12	0.48	2%	4%
TRC	mg/L	Oct. 2013	0.01[2]	0.02[2]	0.028	0.07	53%	67%

Notes:
Red highlighted cells indicate values that exceed the limit.
[1] For non-detect sample results, one-half of the detection limit was used for the calculation of the average except in following cases. For cadmium, 2009-2012 data was not quantified and only the 2013 data is included. For copper, 2009 data was excluded and the highest non-detect level is 0.02, which is also below the permit limit.
[2] The limit for total residual chlorine (TRC) is less than the limit of quantitation (LOQ); compliance with the limit is demonstrated if effluent concentrations measured are less than the LOQ of 0.06 mg/L. Measurements above the limit and above the limit of detection (LOD) of 0.02 mg/L are associated with source identification requirements and increased monitoring.

TABLE 4
Pollutants with Numeric Limits in New NPDES Limits – Petersburg Outfall No. 007
Monitoring Data from January 2009 to December 2013 [5]

Parameter	Unit	NPDES Permit Limits			Historical Monitoring		% of Samples Above Daily Limit	% of Samples Above Monthly Average Limit
		Effective Date	Monthly Avg	Daily Max	Avg	Max	%	%
Boron	mg/L	Sep. 2017	8.3	14.0	3.9	11	0%	13%
Cadmium	mg/L	Sep. 2017	0.002	0.0035	See Note 2	0.01	See Note 2	See Note 2
Lead	mg/L	Sep. 2017	0.0085	0.015	See Note 3	0.01	See Note 3	See Note 3
Mercury	ng/L	Sep. 2017	12	20	14	89	11%	35%
Oil & Grease	mg/L	Oct. 2012	15.0	20.0	2.9[1]	8.1	0%	0%
pH	s.u.	Oct. 2012	--	6.0 to 9.0	--	6.9-8.0	0%	0%
Selenium	mg/L	Sep. 2017	0.033	0.057	0.007[4]	<0.05[4]	0%	0%
TSS	mg/L	Oct. 2012	30.0	100.0	12	52	0%	0%
Sulfate	mg/L	Sep. 2017	1500	2600	1159	1700	0%	8%

Notes:
Red highlighted cells indicate values that exceed the limit.
[1] For non-detect sample results, one-half of the detection limit was used for the calculation of the average.
[2] In the 24 months of cadmium sampling data, only 4 samples were detected at a concentration of 0.01 mg/L. All other results were below the detection limit of 0.01 mg/L. Therefore this is considered low risk of non-compliance.
[3] Of the 24 months of lead sampling data, only 4 samples were detected at a concentration of 0.01 mg/L. All other results were below the detection limits of 0.01 mg/L or 0.0085 mg/L.

TABLE 4
Pollutants with Numeric Limits in New NPDES Limits – Petersburg Outfall No. 007
Monitoring Data from January 2009 to December 2013 [5]

[4] For selenium, only 2012-2013 data are included in the average because the 2009 results were all not detected at 0.05 mg/L. The maximum detected result is 0.02 mg/L.
[5] Recent landfill runoff did not represent normal operational and climate conditions such as in past erosion/runoff issues at the plant.

Water quality data from GE's 2011-2012 study was used to estimate water quality for treatment by group (e.g., FGD, ash, other). The GE data typically included one to three data points per wastewater stream. CH2M HILL updated these comparisons as new data are collected. Water quality for a wastewater group was estimated using flow-weighted average of the various streams that make up that group. For example, the ash transport water group is calculated based on data from the economizer ash water and bottom ash water from each of the four units.

Data on soluble concentrations in wastewater were used because it was assumed that particulate metals would be removed by settling – either in ponds or tank-based treatment. The maximum value in the data sets were used, and compared to one-half the discharge limit, representing a safety factor for operations. The pollutants that had maximum soluble concentrations higher than one-half the discharge limits, and therefore are considered as likely needing treatment beyond just settling, are shown in **Table 5**.

TABLE 5
Comparison of Calculated Wastewater Characteristics to Permit Limit – Petersburg

Parameter	Unit	Limits for Evaluation	FGD	Fly Ash	Bottom Ash[1]	Other	Bottom Ash[1] + Other
Flow, gpm			647	2,733	5,718	5,509	11,227
Current Limits at Outfall No. 001 only							
Copper, Filtered, as Cu	mg/L	0.022	0.004	0.004	0.003	0.021	0.012
Iron, Filtered, as Fe[2]	mg/L	1.0	0.38	0.89	0.016	No data	No data
Zinc, Filtered, as Zn	mg/L	0.2	0.00246[3]	0.00556[3]	0.030	0.0001[3]	0.016[3]
Chromium, Filtered	mg/L	0.19	0.212	0.189	0.137	0.03[3]	0.085[3]
Nickel, Filtered, as Ni	mg/L	0.1	0.385	0.190	0.077	0.051[3]	0.064[3]
Current Limits at both outfalls							
Sulfur, Filtered, as sulfate	mg/L	1,500	10,172	1,008	413	430	421
Cadmium, Filtered, as Cd	mg/L	0.002	0.023	0.026	0.0022	0.0004	0.001
Lead, Filtered, as Pb	mg/L	0.0085	0.0001	0.0001	0.0016	0.0025	0.0021
Selenium, Filtered, as Se	mg/L	0.033	0.638	0.161	0.017	0.003	0.010
Mercury, Filtered	ng/L	12	14,328	9.6	5.7	6.3	6.0
Current Limits at Outfall No. 007 only							
Boron, Filtered, as B	mg/L	8.3	200	22.4	4.4	1.78	3.1

Notes:
Red highlighted cells indicate values that are greater than half of the limit.
Maximum soluble concentrations from the dataset are shown.
Permit has limit on TSS of 30 mg/L. All wastewater groups have over 30 mg/L TSS, but all can be settled to less than 30 mg/L by ponds.
No data = soluble concentrations were not available for iron in the Other wastewater stream; iron is anticipated to be removed in treatment of "Other Water".
[1] Bottom ash includes economizer ash, which is represented by the samples collected from Unit 4.
[2] Values in this table are calculated based on soluble concentrations in each stream. Table does not reflect equipment washes . CH2M HILL's opinion is that the iron exceedances to date are related to particulate iron and/or equipment washes .
[3] Total metal concentrations were used in the absence of soluble pollutant concentrations, which impacted the footnoted values. The pollutants for which total concentrations were used are FGD zinc, Fly and Bottom Ash zinc, and Other zinc, chromium, sulf ate, and nickel. Therefore, though there may be some risk, it cannot be assessed with available information.

It was determined that the FGD wastewater, the Fly Ash transport water, and the Other wastewater, and possibly the Bottom Ash transport water will require additional treatment beyond just settling within the existing ash pond system in order to comply with the final NPDES permit limits.

The bottom ash transport water has some NPDES compliance risk if treated only by settling of the existing ash pond system. If bottom ash water and the Other Water group are allowed to settle out solids, and then discharged to Outfall No. 001 together, post-treatment, (as would be the case if FGD water and fly ash water discharges were eliminated), copper is predicted to be present at greater than one-half the discharge limit (predicted at 12 ug/L versus a limit of 22 ug/L). Use of filtered sample results may slightly under predict settled water quality because some (pollutant-containing) particulate will remain in pond effluent. Pollutants in the Other Water may be over-predicted if the Other Water is treated in an enhanced pond or tank-based system to help remove some of the soluble pollutants.

Considerations and Potential Risks Associated with Wastewater Management Options

The following items were considered in evaluating the overall approach include:

- Current National Pollutant Discharge Elimination System (NPDES) permit limits. This permit sets numeric limits, most derived from water quality based effluent limit calculations. Periodic (weekly, monthly, bimonthly) compliance sampling is required.
- Pending/Future Federal Regulations:
  - While IDEM states in the NPDES permit that the permit may be modified, or alternately, revoked and reissued to comply with any revisions to the federal effluent guidelines applicable to this facility, i.e., the Steam Electric Power Generating effluent guidelines (40 CFR Part 423), if the revised guideline is issued or approved and contains different conditions than those in the permit, the new ELG limits will likely be incorporated during the next renewal of IPL's permits which is anticipated in the fall of 2017.

    Information from the U.S. Environmental Protection Agency (EPA) indicates that they are considering the following requirements in the final ELG:

    - Prohibit discharge of fly ash transport water (industry views as likely).
    - Prohibit discharge of bottom ash transport water.
    - Compliance point with technology-based limits on FGD water prior to mixing with other wastewater. These limits may be very low, to the point that zero liquid discharge (ZLD) may be required.
    - Compliance point with technology-based limits on landfill leachate.
    - Clarification of ELG requirements on metal cleaning waste.
  - Pending CWA 316(a) IDEM guidance might affect IPLs approval of variances from thermal effluent limits such that closed cycle cooling is required. This would create more cooling tower blowdown to be managed in compliance with NPDES limits. The "Other Water" treatment system has been sized to accommodate additional cooling tower flow from adding cooling towers to Petersburg Unit 1 (and increasing towers on Unit 2).
  - Pending CWA 316(b) rules may result in IPL deciding to construct additional cooling towers as a method of reducing intake flows and complying with this regulation. This would create more cooling tower blowdown to be managed in compliance with NPDES limits. The "Other Water" treatment system has been sized to accommodate additional cooling tower flow from adding cooling towers to Petersburg Unit 1 (and increasing towers on Unit 2).
  - Coal Combustion Residuals (CCR) management may be affected by regulation or possibly legislation. EPA issued a Draft CCR Rule in June 2010, but its progress has been stalled. This rule will potentially either require ponds containing CCRs (such as ash and FGD solids) be closed, or will require the ponds to have a composite liner, leachate collection, groundwater monitoring, risk evaluations based on location, and closure plans that would make them much more expensive. IPL has previously done a study on the Draft CCR Rule of 2010. This study determined that in order to comply with the Rule as proposed IPL would be required to phase out the use of CCR ponds.
- Other Risks:
  - Unproven/Emerging Technology. Some of the treatment technologies being considered have only a few applications treating the wastewater streams needing treatment. The area with least full-scale application is FGD water treatment by biological or thermal ZLD treatment. Even the treatment system used by EPA to define Best Available Technology (BAT) for FGD water of physical/chemical treatment plus biological

treatment does not meet the ELG limits consistently at all the plants it is currently used for. This was described in comments by EPRI, UWAG, and Duke Energy to the EPA on the proposed ELG.

- The forecasts of future discharge water quality are based on limited available data. Some streams, most notably bottom ash water and economizer ash water, have only a few data points to use in forecasting compliance with discharge limits.

Wastewater Management Options Considered

The treatment technologies considered are summarized in **Table 6**. Information and figures on these treatment options were included in various meeting presentations. In addition to treatment, the following approaches have been evaluated:

- Change discharge from Lick Creek to White River. This change may result in higher WQBELs limits or potentially elimination of some pollutant WQBELs. It would not affect technology-based limits in current NPDES permit and potential future Effluent Limitation Guidelines limits – such as numeric limits anticipated on FGD water, or possible prohibition on ash transport water discharge.
- Negotiate to change the boron discharge limit. Outfall No. 007 currently has a water quality based limit of 8 milligrams per liter (mg/L). It is anticipated that IDEM will set a similar limit on Outfall No. 001 once sufficient data are available for a Reasonable Potential to Exceed calculation. This limit would require treatment, and treatment technologies to reach such a boron limit are very limited. CH2M HILL evaluated the calculation method used to develop this limit and concluded that it does not appear that newer toxicity results would help raise the boron limit. In addition, changes to a final permit limit that make it less stringent will trigger an anti-backsliding review by EPA Region 5 and IDEM. There is a moderate-high probability risk that these agencies would not permit a less-stringent boron limit.
- Re-route flows from Outfall No. 007 to the Outfall No. 001 system to avoid need for separate treatment. Because Outfall No. 007 receives stormwater flows from sizeable areas (e.g., the 40-acre landfill), the costs associated with treatment of the corresponding flows in a tank-based system would be high and this option would not be cost-effective. Furthermore, there is a high probable risk of future regulatory adaptability.
- Cover the IUCS calcium sulfite/ash pile and the outdoor gypsum pile, which would eliminate the runoff from these areas and the truck wheel wash water. See Appendix D for additional detail of this compliance evaluation.

Other treatment options were evaluated but rejected near the project onset because having no applications with similar wastewater, 'fatal flaw' risks, and/or due to professional judgment that costs would be significantly higher than other treatment technologies. These are summarized in **Table 7**.

TABLE 6

WASTEWATER MANAGEMENT OPTIONS CONSIDERED

Management Option	Description	Risk of Non-Compliance with Discharge Limits	Likelihood of Noncompliance with Future Regulations based on Proposed Rules	Risk of Operations Reliability Problems	Land Requirements	Eliminates CCR Ponds?
Pond treatment	Continuing to treat wastewater in ponds as is currently done	High risk of non-compliance if continuing to send all wastewater streams because historic effluent data show many occurrences of effluent above the pending discharge limits. May be lower risk for cleaner water streams (such as bottom ash water).	High probability of risk if future CCR requirements drive IPL to line and/or close ponds. High probability of risk for ELG non-compliance.	Low-to-moderate risk. Dredging to maintain pond volume required	Uses existing ponds, but these do require dredging and storage of dredged solids.	No. If ponds used for CCR (FGD or Ash) would mean modifying ponds to be in compliance with CCR rule, or would need to close ponds and add tank-based physical/chemical treatment. Therefore, risk that investment in enhanced pond system would be lost. Appears CCR rule would require compliance in 5 to 7 years after issued final (which is anticipated in late-2014). If ponds used for non-CCR streams (such as cooling tower blowdown), this would not be a risk.
Enhanced Pond treatment	Treat wastewater in ponds, but would also include adding chemical feed system and mix tanks to convert some soluble or small particulate metals into larger solids that will be removed in the ponds. A liner may be required if building over existing ponds. Liner recommended for the “Other Water” group, since it does not have much solids to form a layer atop the old solids.	High risk of non-compliance for streams that have selenate above Se discharge limit (Fly Ash, FGD). Moderate-high risk for streams that have soluble mercury above Hg discharge limit (Fly Ash, FGD)	High probability of risk if future CCR requirements drive IPL to close ponds/location restrictions. High probability of risk for ELG non-compliance associated with FGD and Ash Sluice WWs.	Low-to-moderate risk. Solids removal from enhanced pond will be needed periodically.	Uses existing pond area, but these do require dredging and storage of dredged solids. A liner may need to be added. Adding the tanks for enhancing will require roughly 0.1 acre.	
Tank-based physical or physical/chemical treatment	Constructed treatment plant with physical liquid/solid separation through clarifiers and subsequent dewatering of solids (e.g., filter press). May also include filter. May include chemical feed systems and mix tanks to help removal of dissolved parameters. If used for bottom ash or “other” water, would include bottom ash removal as first step (such as with a submerged flight conveyor) for bottom ash treatment option only.	Lower risk of non-compliance for those parameters removed by physical/ chemical treatment (cationic metals such as Cu, Ni, Cd, selenite such as Bottom Ash). Moderate risk for Hg due to very low limits (Fly Ash and FGD). High risk for parameters not removed by physical/chemical treatment (selenate, boron, chloride) (FGD and Fly Ash).	Solids separation is needed as pre-treatment for other forms of treatment considered (biological, ZLD with recycle). Hence, there is low probability of risk that this technology would not be incorporated into future system. If treatment and discharge used for bottom ash, there is moderate probability of risk that ELG will ban this discharge. High probability of risk with fly ash. Moderate probability of risk with bottom ash based on proposed ELG. Low risk for “other” water based on proposed ELG. Risk for CCR - low	Low-moderate risk. Requires more operator attention than pond-based. Well-proven technology. Must monitor and adjust chemical feed systems to maintain optimal treatment.	Rough estimate of 6 acres for a campus of physical/chemical systems for FGD, Ash, and Other streams.	Yes.
Dry fly ash handling	Eliminate discharge of fly ash transport water through use of vacuum and/or pressure dry fly ash transport systems.	None, as wastewater discharge is eliminated	None	Low risk (dry fly ash handling is a well-proven technology)	Small	Yes
Passive biological treatment (downstream of pond or physical/chemical treatment)	Constructed system consists of lined, in-ground biological reactors. Filled with organic material. Can also use supplemental liquid carbon source feed system, if needed. Bacterial processes used to remove selenate. May also help treat other pollutants.	Moderate-High compliance risk with selenium limits in NPDES permit. Moderate Hg compliance risk	Moderate probability of risk because if future limits necessitate ZLD (such as boron), would no longer have need for biological treatment. Moderate-high probability of risk of meeting ELG selenium limits on FGD water. Low-moderate probability of risk that final CCR will regulate these type of surface impoundments.	Moderate risk (because reliant on multiple processes: physical/chemical and biological).	Land requirement is a function of nitrates in wastewater. Likely will be requiring over 30 acres to treat the stations FGD wastewater.	Yes (assumes system would be built in lined, CCR-compliant ponds)
Tank-based biological treatment (downstream of pond or physical/chemical treatment)	Constructed treatment plant with chemical feed system (for carbon source), bioreactor, and would use same dewatering as physical/chemical system. Bacterial processes used to remove selenate. Will also help treat other pollutants such as Hg.	Low-Moderate risk of selenate compliance risk. More proven in FGD water than passive – six known systems versus two for passive.	Moderate probability of risk because if future limits necessitate ZLD (such as boron) and/or ELG Se limits remain low or more stringent, would no longer have need for biological treatment.	Moderate risk (because reliant on multiple processes: physical/chemical and biological). Requires more operator attention than passive. Must monitor and adjust	Requires about 2 acres per biological treatment system, when added to a treatment campus.	Yes.

TABLE 6

WASTEWATER MANAGEMENT OPTIONS CONSIDERED

Management Option	Description	Risk of Non-Compliance with Discharge Limits	Likelihood of Noncompliance with Future Regulations based on Proposed Rules	Risk of Operations Reliability Problems	Land Requirements	Eliminates CCR Ponds?
	Multiple configurations were considered: fixed bed bioreactors (such as the GE ABMet) and fixed film in fluidized bed reactor (FBR) or mixed bed biological reactor (MBBR). GE ABMet was carried further in evaluation because FBR not used full-scale on FGD water.	Lowers Hg compliance risk by polishing Hg after physical/chemical treatment.		chemical feed systems to maintain optimal treatment. If biological system's bacterial population inhibited or killed, can take weeks to recover treatment.		
Zero valent iron (ZVI)	Constructed treatment plant with chemical mix tanks, clarifiers, dewatering (filter press). ZVI reacts with trace pollutants, including selenate.	Moderate-high as no full-scale systems in service on FGD water.	Moderate probability of risk because if future limits necessitate ZLD (such as boron), would no longer have need for biological treatment. Also, this system may necessitate the need for treatment after ZVI to remove ammonia (ammonia was generated during the bench-scale treatment of ZVI).	Moderate-High risk (unproved in full-scale).	Not estimated	Yes.
Thermal zero liquid discharge (ZLD)	Uses electric power and/or steam to distill off water. Two levels evaluated: 1. Evaporator – produces a brine (which can be disposed of by using for wetting fly ash) 2. Crystallizer – further reduces brine to a salt cake. This option would likely require softening water in physical/chemical.	Low risk. Eliminates discharge, so no risk of non-compliance.	Low probability of risk.	Moderate risk (because reliant on multiple processes: physical and thermal ZLD).	Requires approximately 2 acres.	Yes.
ZLD by reuse	Reuse in plant. Suitable for low-salt wastewater (Bottom Ash Transport water, some "Other Wastewater" streams).	Low risk. Eliminates discharge, so no risk of non-compliance.	Low probability of risk.	Low risk (assumes good solids removal so does not cause abrasion or fouling in reuse system).	Little land use.	N/A (could be used with ponds or tank-based treatment).

* - Downstream of pond or physical/chemical treatment

TABLE 7
Alternatives Evaluated Early and Rejected

Water Group	Compliance Strategy Option Evaluated	Evaluation
FGD	Reverse Osmosis	Risk of scaling membranes, requires treatment of brine, not used on FGD water elsewhere
FGD	Boron treatment by precipitation and ion exchange	Done at only one plant (Cayuga), which has much higher discharge limits than the 8 mg/L limit IPL faces. The treatment system has had significant operational challenges.

Alternatives Evaluation – Phase 1

Alternatives were evaluated by considering the various treatment options for each of the three wastewater streams (FGD, Ash, and Other). Initially, 37 permutations of treatment were considered, with costs developed for each, as shown in **Table 8**. Justifications for elimination are shown in the notes section of **Table 8** and include the following:

- Eliminated options which included treating wastewater streams together that increased risk of non-compliance
- Eliminated options which viewed as having high risk of non-compliance with current discharge limits such as FGD water by pond-based (not likely to comply with Hg or Se limits) or physical/chemical treatment (not likely to comply with Se limits) for FGD water.
- Eliminated options that included more treatment than was considered needed.

TABLE 8
Initial Alternatives Evaluated – With Results of Screening Done October 2012 (“Overall Approach” Phase)

#	Justification	Description
~~1~~	~~Note 3~~	~~Segregated trt. FGD: P/C + tank-based bio. Ash: P/C, recycle. Other: Enhanced Pond+ tank-based bio.~~
~~2~~	~~Note 3~~	~~Segregated trt. FGD: P/C + passive bio. Ash: P/C, recycle. Other: Enhanced Pond + passive bio.~~
~~3~~	~~Note 3~~	~~Segregated trt. FGD: P/C + tank-based bio. Ash: P/C, recycle. Other: P/C+tank-based bio.~~
~~4~~	~~Note 3~~	~~Segregated trt. FGD: P/C + tank-based bio. Ash: P/C, recycle. Other: P/C+passive bio.~~
~~5~~	~~Note 1~~	~~Segregated trt. FGD: P/C + tank-based bio. Ash: P/C, recycle. Other: P/C.~~
~~6~~	~~Note 1~~	~~Segregated trt. FGD: P/C + passive bio. Ash: P/C, recycle. Other: P/C.~~
7		Segregated trt. FGD: P/C + tank-based bio. Ash: P/C, recycle. Other: Enhanced Pond
8		Segregated trt. FGD: P/C + passive bio. Ash: P/C, recycle. Other: Enhanced Pond
9		Segregated trt. FGD: P/C + ZLD. Ash: P/C, recycle. Other: Enhanced Pond.
~~10~~	~~Note 1~~	~~Segregated trt. FGD: P/C + ZLD. Ash: P/C, recycle. Other: P/C.~~
~~11~~	~~Note 3~~	~~Segregated trt. FGD: P/C + ZLD. Ash: P/C, recycle. Other: P/C+tank-based bio~~
~~12~~	~~Note 3~~	~~Segregated trt. FGD: P/C + ZLD. Ash: P/C, recycle. Other: P/C+passive~~
13		Segregated trt. FGD: P/C + tank-based bio. Ash: P/C, discharge. Other: Enhanced Pond.
14		Segregated trt. FGD: P/C + passive bio. Ash: P/C, discharge. Other: Enhanced Pond.
15		Segregated trt. FGD: P/C + tank-based bio. Ash: pond, discharge. Other: Enhanced Pond.
16		Segregated trt. FGD: P/C + passive bio. Ash: pond, discharge. Other: Enhanced Pond.
~~17~~	~~Note 1~~	~~Segregated trt. FGD: P/C + tank-based bio. Ash: P/C, discharge. Other: P/C~~

TABLE 8
Initial Alternatives Evaluated – With Results of Screening Done October 2012 (“Overall Approach” Phase)

~~18~~	~~Note 1~~	~~Segregated trt. FGD: P/C + passive bio. Ash: P/C, discharge. Other: P/C~~
~~19~~	~~Note 3~~	~~Segregated trt. FGD: P/C + tank-based bio. Ash: P/C, tank-based bio, discharge. Other: P/C+tank-based bio~~
~~20~~	~~Note 3~~	~~Segregated trt. FGD: P/C + passive bio. Ash: P/C, passive bio, discharge. Other: P/C+passive bio~~
21		Segregated trt. FGD: P/C + ZLD. Ash: P/C, discharge. Other: Enhanced Pond.
~~22~~	~~Note 1~~	~~Segregated trt. FGD: P/C + ZLD. Ash: P/C, discharge. Other: P/C~~
~~23~~	~~Note 3~~	~~Segregated trt. FGD: P/C + ZLD. Ash: P/C, discharge, tank-based bio. Other: P/C+tank-based bio~~
~~24~~	~~Note 3~~	~~Segregated trt. FGD: P/C + ZLD. Ash: P/C, discharge, passive bio. Other: P/C+tank-based bio~~
~~25~~	~~Note 2~~	~~Combined P/C for Ash and other. Tank-based P/C for FGD. Combined tank based biological~~
~~26~~	~~Note 2~~	~~Combined P/C for Ash and other. Tank-based P/C for FGD. Combined passive biological~~
~~27~~	~~Note 2~~	~~Combined pond for Ash and other. Tank-based P/C for FGD. Combined tank based biological~~
~~28~~	~~Note2~~	~~Combined pond for Ash and other. Tank-based P/C for FGD. Combined passive biological~~
~~29~~	~~Note 4~~	~~Combined pond for Ash and other. Enhanced Pond for FGD. Combined tank-based biological~~
~~30~~	~~Note 4~~	~~Combined pond for Ash and other. Enhanced Pond for FGD. Combined passive bio logical~~
~~33~~	~~Note 4~~	~~Combined pond for Ash and other. Enhanced Pond for FGD. FGD tank-based biological~~
~~34~~	~~Note 4~~	~~Combined pond for Ash and other. Enhanced Pond for FGD. FGD passive biological~~
~~35~~	~~Note 4~~	~~Recycle ash, enhanced pond for FGD, pond for other, combined tank-based biological~~
~~36~~	~~Note 4~~	~~Recycle ash, enhanced pond for FGD, pond for other, combined passive biological~~
37		Piping, outfall, permitting to move discharge to White River

Notes

1 - Appears do not need tank-based physical/chemical treatment for Other Wastewater, good likelihood of meeting limits with just Enhanced Ponds, therefore eliminated option(s) due to high cost associated with not needed technology. NOTE: this early-phase decision was later reversed due to increase in cost estimate of enhanced pond.

2- Better to segregate FGD wastewater. High Probability of Risk regarding future regulatory adaptability (ELG).

3- Appears do not need biological treatment for Other Wastewater, good likelihood of meeting limits with just Enhanced Ponds or tank-based treatment, which are lower-cost options.

4- High compliance risk (mercury). Also, those options that did not have biological or ZLD treatment of FGD water were eliminated due to risk of non-compliance with selenium limit in NPDES permit, and high probability of risk related to future regulatory adaptability (ELG).

Alternatives Evaluation – Phase 2

The alternatives that remained after the first phase were further evaluated by refining designs and costs, evaluating various types of technology within some categories (such as types of biological treatment), and treatability testing of some technologies. The second phase of the alternatives evaluation included meetings on December 6, 2012 and January 15, 2013 in which some alternatives were screened out. Additional work was then done during 2013 to further narrow down to the selected compliance strategy.

Phase 2 Evaluation of FGD Water

It was determined in Phase 1 that ZLD or advanced biological treatment was required. This was driven by the fact that selenium in forced oxidation FGD systems is present as selenate at levels representing a high compliance risk with the NPDES discharge limits on selenium, and high risk with the proposed ELG limit on selenium in FGD water. This resulted in the following alternatives remaining for evaluation in Phase 2:

- Physical/chemical treatment plus biological treatment using the GE ABMet process;

- Physical/chemical treatment plus biological treatment using the FBR process (Note that MBBR was also evaluated, but was considered less-proven and similar cost to FBR so was screened out.);
- Physical/chemical treatment plus biological treatment using passive biological treatment;
- ZVI;
- "Near ZLD" in which thermal evaporator used, and brine disposed of as wetting agent for fly ash; and
- "Total ZLD" in which thermal evaporator and crystallizer used to produce solid salt cake for disposal.

FGD Water – Selection of Preferred Biological Treatment Process

Biological treatment using ABMet reactors was selected for further consideration over passive biological, FBR, and ZVI because the other technologies had little or no full-scale application with FGD water. Also, ZVI showed ammonia formation in bench-testing of IPL FGD water (a non-compliance risk due to toxicity). This decision was made during the December 2012 team meeting. At that time the cost comparison of the alternatives was as shown in **Table 9**.

The land required for anoxic, anaerobic and aerobic treatment was estimated to be roughly 30 acres for Petersburg for removal of selenium and nitrate sufficient to get selenium removal (including redundancy, separating berms and support equipment). Additionally, the proposed ELGs require an extremely low level of nitrate and nitrites. Passive biological treatment generates organic nitrogen compounds in excess of the low nitrate and nitrite limits proposed in the ELG, which may require additional active biological treatment after typical passive treatment systems, increasing cost and land area required considerably. Based on land requirements, and issues associated with nitrate and nitrite limits, passive treatment is considered a moderate-high risk of NPDES noncompliance (selenium final limit in NPDES permit) and therefore was not considered further.

TABLE 9
FGD Wastewater Treatment Alternatives Evaluation in December 2012

Alternatives	Capital Costs for FGD Treatment	Annual O&M Costs for FGD Treatment	Risk Notes
Physical/Chemical + Passive biological	$86,000,000	$2,300,000	Used at two sites on FGD water, not proven to meet NPDES permit limits and high probability of risk regarding future regulatory adaptability (ELG)
Zero Valent Iron (ZVI)	$86,000,000	$3,300,000	Not used on FGD water full-scale
Physical/Chemical + FBR biological	$101,000,000	$3,300,000	Not used on FGD water full-scale
Physical/Chemical + ABMet biological	$115,000,000	$3,100,000	A few full-scale applications on FGD water (this technology was used by EPA in setting BAT limits for FGD treatment in the proposed ELG)

FGD Water – Selection of Preferred ZLD Process

Sub-alternatives were developed for the ZLD treatment of FGD water: 'near ZLD' where an evaporator is used to reduce the wastewater to a brine that is mixed with ash and landfilled, and total ZLD where wastewater is reduced to a salt cake using an evaporator and crystallizer 'Near ZLD' was chosen due to significantly lower cost than total ZLD, because there is adequate fly ash to use in disposal of the FGD ZLD brine, and because of concerns with operability of crystallizers on FGD water.

The ZLD option was refined during the project to include recycling a portion of the FGD water back to the FGD with just solids removal thereby reducing the size of the evaporator and softening. This lowered cost of this option. The flow of FGD system blowdown at both the Harding Street and Petersburg stations is driven by fine solids content rather than chlorides. A "ZLD with Recycle" approach was developed in which FGD water blowdown is split into two streams. A portion of the FGD wastewater is treated by physical/chemical treatment (clarifier) and then recycled to the FGD system. A smaller portion of FGD wastewater is treated with softening and evaporation, producing two liquid streams:

- Evaporator distillate, which can be reused in the power plant (recycled to the FGD system, or may be used in other high purity uses in the power plant if the ELGs allow it)
- Evaporator brine to be mixed with fly ash and transported offsite for disposal in a landfill

Within the ZLD options, the "near ZLD" with recycle of some water back to the ZLD was selected due to its lower cost compared to ZLD without recycle (see Table 10).

FGD Water – Selection Between Physical/Chemical plus Biological Treatment versus ZLD

CH2M HILL recommends ZLD (specifically "near ZLD" with recycle) because it has lower risk and has comparable cost as ABMet biological tank-based treatment, as shown in Table 10 and Figure 1. Specific issues that made this biological treatment option risks higher include:

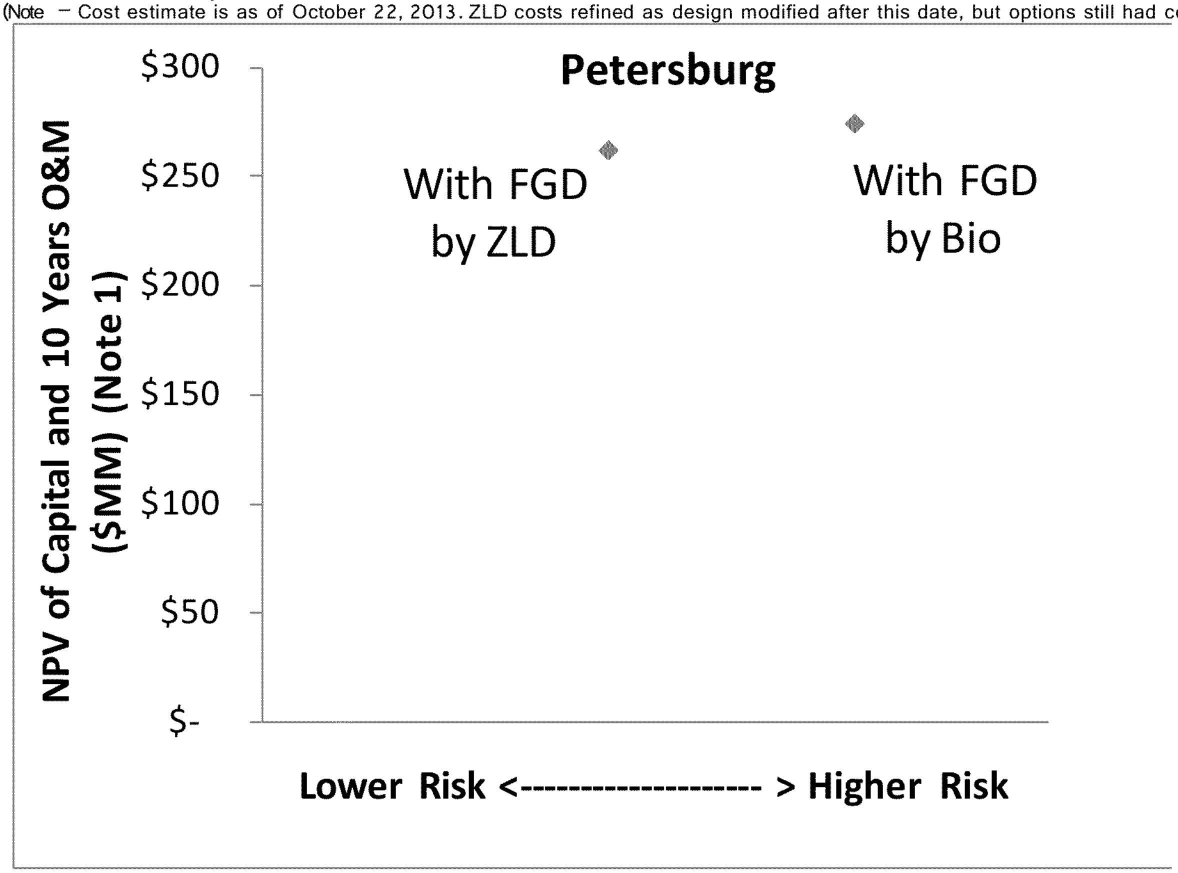
- Water quality limits in NPDES permit. Discharging treated FGD water would increase risk of non-compliance compared to not discharging it (as would be the case in the ZLD option).
- Future water quality limits:
  - Although Outfall No. 001 does not currently have a limit for boron, the Petersburg Station has a monitor and report requirement, and a limit is highly probable in the future similar to the boron limits contained in the Petersburg NPDES permit Outfall No. 007. The current monitoring data collected starting in October 2012 is above the calculated limit for discharge to the White River and there is a high risk of future limit adaptability which may result in the need for a different type of treatment system such as ZLD treatment and most cost spent on biological system could not be transferred to a ZLD system (technologies are two different systems with little overlapping parts).
  - Future water quality based limits, such as salinity, may not be met with FGD water treated by biological treatment and then discharged.
  - There is risk that MATS will change the FGD wastewater chemistry, thereby affecting the levels of selenium and/or mercury removal that biological treatment can achieve, which may result in a higher probability of non-compliance risk with the NPDES permit limits if using biological treatment.
  - A pilot system of tank-based physical/chemical treatment followed by biological treatment (GE ABMet) was tested using Petersburg's FGD water. The pilot system ran at steady state for 13 weeks and the team collected 26 samples for laboratory analyses. During this limited period, the pilot test results showed that the system was in compliance with ELG limits (arsenic, mercury, nitrate and nitrite, and selenium). However, there was some risk remaining of non-compliance with limits in the NPDES permit final discharge limits if the treated water were discharged to Outfall No. 001. This is discussed further in the CSP **Section 4**. Additionally, during the pilot test the ZLD option was refined by adding the recycle concept to reduce cost. This made ZLD cost-competitive with biological treatment, and hence it was chosen as the lower risk option.

TABLE 10
FGD Wastewater Treatment Alternatives Evaluation in October 2013

Alternatives	Capital Costs for Full Compliance Strategy*	Annual O&M Costs for Full Compliance Strategy*
FGD by physical/chemical plus biological treatment	$209,000,000	$8,000,000
FGD by ZLD; with recycle	$202,000,000	$7,400,000
FGD by ZLD; no recycle	$236,000,000	$8,600,000

*- This "full compliance strategy cost" comparison was done to isolate the FGD cost differences with a common assumption of dry fly ash handling, bottom ash water by physical treatment with recycle, and Other Water treated by enhanced pond. Note that this is not necessarily the final compliance strategy for bottom ash water or Other water.

FIGURE 1.
FGD Wastewater Compliance Decision Grid
(Note – Cost estimate is as of October 22, 2013. ZLD costs refined as design modified after this date, but options still had comparable costs)



Phase 2 Evaluation of Ash Water

As was described in the Overall Approach section above, dry fly ash handling was selected as the recommended compliance strategy. This choice was made based on fly ash water's loading of pollutants regulated in the NPDES permit, and because it offered a lower risk and lower cost than treating the fly ash water to NPDES discharge limits either by itself or combined with other streams. Both IPL stations already have some infrastructure in place to handle ash dry, which assists in the elimination of wet fly ash handling. This leaves the need for a compliance strategy for bottom ash, economizer ash, and air preheater ash. Early steps of the alternative evaluation screened out most options for these ash waters, leaving a selection from the following options: tank-based physical treatment plus recycling, tank-based physical/chemical treatment plus discharge, or pond treatment with discharge.

Pond Treatment

Use of enhanced ponds (new, lined ponds) for bottom ash was considered in the early phases of the project. However, it was rejected as a risk of spending significant capital (tens of millions of dollars) on treatment that may later become obsolete. Therefore, the pond option entails continuing to use the existing ponds. This is the lowest cost option.

If ponds are used, the water will need to be discharged rather than recycled because the net increase in water into the system due to precipitation would necessitate some wastewater discharge. Also, if the bottom ash water is mixed with other, saltier water, the salts would build up and cause risk of scaling and corrosion.

As was shown in Table 5 and in the CSP Appendix E, discharge of bottom ash transport water has some compliance risk if treated in ponds. Based on limited data available, it appears discharging bottom ash water treated in existing ash ponds plus new treatment chemical addition has low risk (mercury and cadmium). CH2M HILL recommends adding chemical feed and aeration to the existing ponds to help mitigate this risk, at a relatively low cost.

If ponds are used it is possible that they may need to be replaced later with tank-based treatment due to the potential CCR Rule requirements on ponds (to have liner, leachate collection, groundwater monitoring, etc.). It is also possible that discharge may need to be replaced with recycle if the final ELG bans discharge of bottom ash water. The time period of potential technology replacement will be driven by the timing and requirements of the CCR and ELG rules. Currently, the CCR rule is projected to be finalized in December 2014 and the ELG rule is projected to be finalized by the end of September 2015. The compliance schedules are uncertain, but currently anticipated 5 to 7 years from finalization of the CCR Rule, and during the next NPDES permit renewal for the ELG Rule. The “cost penalty” of changing from pond-based treatment to tank-based treatment is primarily the cost of doing two projects: more engineering, procurement, construction management, and contractor mobilization. The estimated risk cost is $1.6 million. This allows IPL to, at a minimum, delay additional cost until more certainty exists around the outcome and timing of potential future regulations.

Other considerations evaluated associated with the continued use of the existing ash pond system for bottom ash treatment included:

- Decreasing pond volume. The Petersburg ash pond system retention time would be decreased if build a new enhanced pond within it for the Other Water group. The pond system size is also reducing due to filling with ash. It is CH2M HILL’s opinion that this size reduction underlines the need for adding chemicals to improve settling of bottom ash solids in the existing pond system. And by adding treatment chemicals, even the reduced Petersburg pond area should be sufficient to achieve treatment goals of bottom ash water in the pond system. This would not be the case if the new chemical addition system is not added.
- Pond Stability. IPL has noted that the Petersburg pond system has some stability concerns with Ponds B and C. If sluicing Pond A dredged CCR materials to these ponds is continued for several years, the excavation required to maintain the ponds will likely necessitate work to remedy the stability issues.
- Groundwater. Continuing to treat bottom ash water in the pond system, and enhancing the removal of trace pollutants (such as mercury) by chemical precipitation, may have more impact on groundwater underlying the pond then stopping the use of the existing pond system and instead treating bottom ash water in tank-based treatment. It is CH2M HILL’s opinion that there is very minimal (if any) risk that the proposed treatment chemicals (polymer and organosulfide) would migrate into groundwater in detectable quantities (if at all). The chemicals will be added at part-per-million levels, and should be bound to solids that then stay in the pond.

- Limited data to assess risk. It should be noted that the water quality data used to assess non-compliance risk (Table 4) is limited, with only a few samples of bottom ash water.
- Compliance risk of discharging bottom ash. If bottom ash water is treated in a tank-based system and then recycled and FGD water is treated in a ZLD system, the only discharge to Outfall No. 001 will be the Other Water, which is treated in a new enhanced pond. If bottom ash is managed in existing ash ponds and discharged, Outfall No. 001 will receive a mixture of the bottom ash water and the Other Water. Bottom ash water discharge via existing ash ponds, with new chemical and aeration addition, and then mixing with Other Water (treated in its own enhanced pond) should reduce the overall risk of non-compliance versus Other Water discharge alone. This is because bottom ash water after chemical and aeration addition and settling in the pond should be lower in regulated parameters than Other Water. This is based on the limited IPL data set, as well as data and CH2M HILL experience at other power plants. However, the bottom ash water discharge via ponds will likely have some increase to risk on occasion – namely when dredging, wind-blown pond turbulence, or other solids-disturbing event causes increased solids carryover from the pond.

Tank-Based Treatment

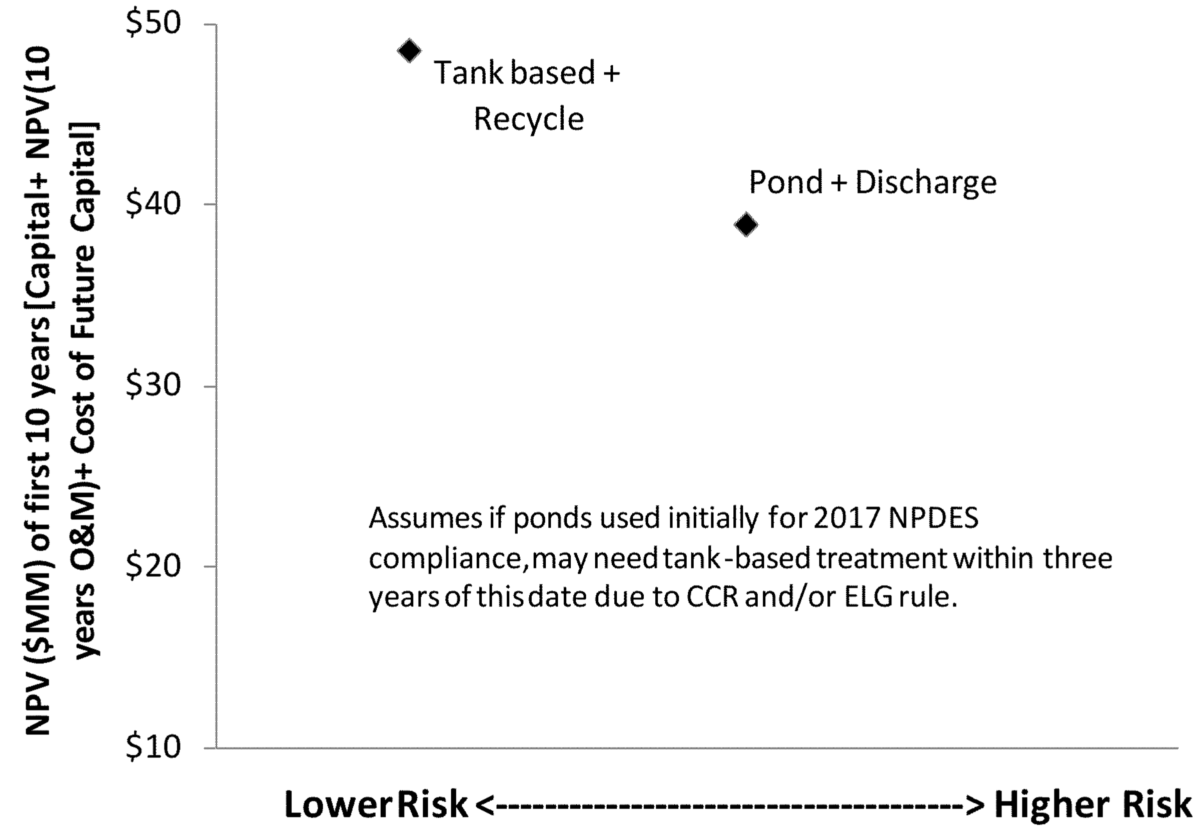
In considering tank-based treatment, the project team chose recycle over discharge because discharge would be similar or higher cost due to need for additional treatment to remove fine solids. Recycle requires more pumping and piping, while discharge would require a secondary clarifier added to treatment system to meet suspended solids limits. Recycle was also preferred because recycling will eliminate potential risk of discharge non-compliance with the current NPDES permit, and because recycling also eliminates the potential risk of having to change wastewater management to comply with the final ELGs, which may ban discharge of bottom ash transport water.

Compliance Strategy Recommendation

In conclusion, continued treatment in ash ponds, with addition of chemical feed and aeration to mitigate risk of non-compliance was chosen as the recommended compliance strategy because of lower initial capital costs.

The cost comparison of pond treatment versus tank-based treatment with recycle is shown in **Appendix E** and **Figure 2**.

FIGURE 2
Relative Risk of Non-Compliance with Current Limits and Costs -- Ash Water Options



Phase 2 Evaluation of Other Water

Early steps of the alternative evaluation screened out most options for Other Water because they were believed to provide more treatment than needed in order to achieve compliance, leaving two alternatives to select between for Other water: treatment by tank-based physical/chemical treatment or enhanced pond treatment.

Early cost estimates (2012) showed pond-based treatment to be lower cost than tank-based, but as more information was obtained in 2013 through further geotechnical investigation of the ash pond and in 2014 through discussions with IDEM about the requirements for building a new pond within Pond A and closing the ponds, the cost estimate for the enhanced pond approach became higher than the tank-based treatment cost estimate. There is not room on the site to build the enhanced pond other than on retired ash ponds. This is shown in Table 11 and Figure 3.

TABLE 11
Other Wastewater Treatment Alternatives Evaluation

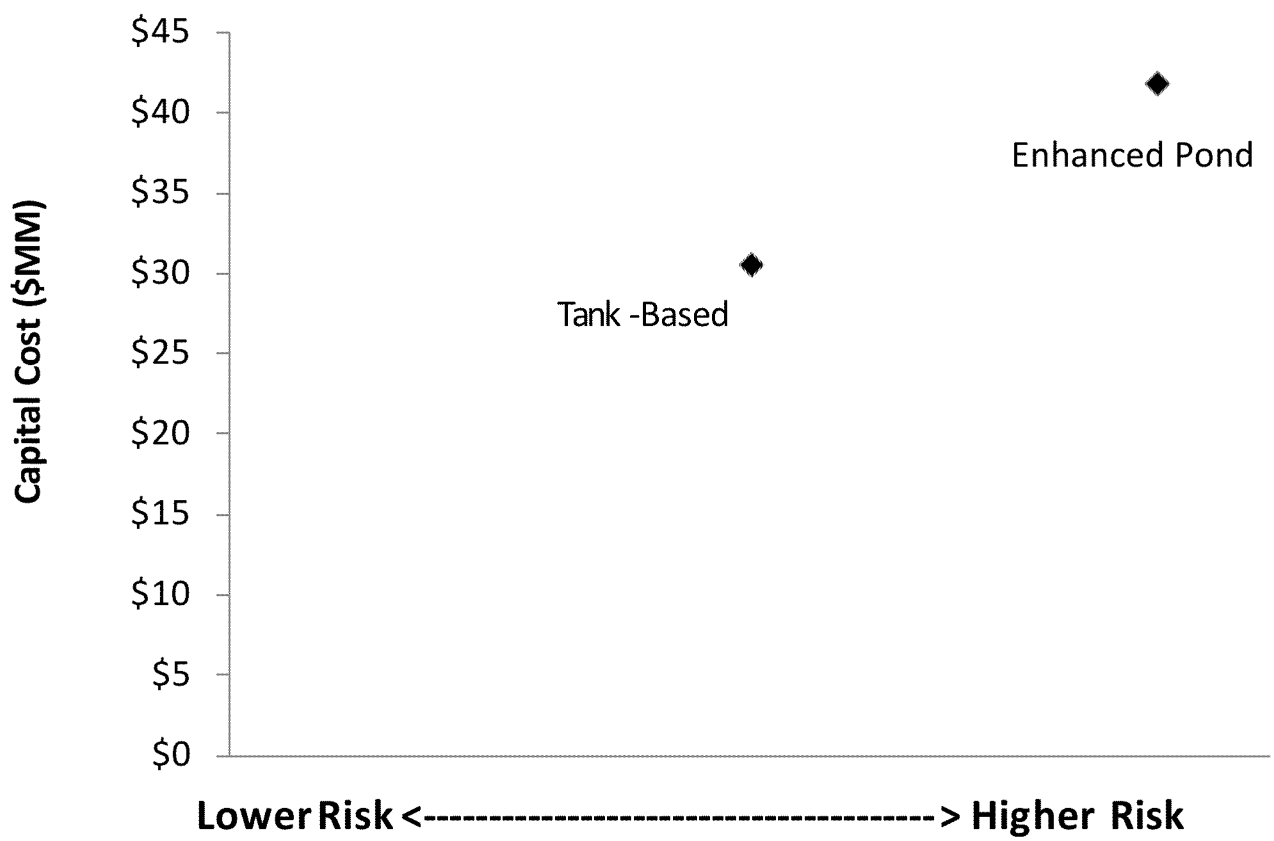
Alternatives	Capital Costs for Just the Other Water System ($ millions)	Annual O&M Costs for Just the Other Water System
Other Water by new Tank-based Treatment	$30	O&M costs are roughly equal between options
Other Water by new Enhanced Pond	$41	

Notes:

The tank-based option would also require a future cost to expand stormwater surge capacity for period after ash ponds not discharging water, but not yet covered.

*- This "full compliance strategy cost" comparison was done to isolate the Other Water cost differences with a common assumption of FGD by ZLD, dry fly ash handling, and bottom ash water by existing ponds.

FIGURE 3
Relative Risk of Non-Compliance with Current Limits and Costs -- Other Water Options
Costs shown are for entire compliance system capital costs. O&M costs for the Other Water portion of two options are comparable.



Due to land restrictions at the facility, there is no room to build the enhanced pond other than on top of retired ash pond unit(s). Risks associated with enhanced pond treatment include:

- There is less cost certainty at this time because additional geotechnical information and the chosen means of construction could significantly increase or decrease costs from CH2M HILL's cost estimate based on preliminary information. EPC bids will be required to improve cost certainty.
- One potential advantage of building an enhanced pond on an out-of-service ash pond is that the new pond's underlying liner would form a portion of the closure of the former pond. However, there is a moderate-to-high risk of not getting such a closure plan approved within the timeframe that this NPDES wastewater system is needed and in the same design concept as proposed.
- There is a moderate probability of risk that the final CCR Rule will require closure or lining of ponds that contain non-CCR wastestreams (such as this Other water group).Seal trough water (which carries small amounts of bottom ash) will be managed in this Other Water treatment system. (The system may be modified in the future to re-route this

seal trough water to be managed with bottom ash water. This determination will be made once CCR and ELG rules are finalized.)

- Pond-based treatment offers less treatment for mercury and other metals than tank-based.

Based on our understanding of costs and risks, CH2M HILL recommends that tank-based treatment is the best approach to address this treatment need.

Evaluation of Outfall No. 007 Water

The recommended alternatives were determined based on cost and risk. The project team also considered stormwater-management requirements of the current permit, and potential requirements in future permits. More information on the Outfall No. 007 alternative evaluation is included in the CSP **Appendix D**.

Appendix D
Petersburg Station Outfall No. 007
Compliance Alternative Evaluation

DRAFT MEMORANDUM CH2MHILL®

Indianapolis Power & Light – Petersburg Outfall No. 007 Compliance Options Evaluation

PREPARED FOR:	Nysa Hogue/IPL
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PREPARED BY:	CH2M HILL
DATE:	October 17, 2013 Revised: January 7, 2014

Summary

The current discharge flows to Petersburg Outfall No. 007 exceed the final limits for several parameters in the current NPDES permit, which become enforceable in September 2017. This evaluation presents options for ensuring compliance with the current and future permit limits for the wastewater streams that currently flow to Outfall No. 007. The goal is to evaluate options for Outfall No. 007 to ensure compliance with current and future limits in a cost-efficient and low risk manner, for inclusion in the Petersburg National Pollutant Discharge Elimination System (NPDES) compliance strategy plan. The streams that were evaluated include the following:

- IUCS (Illinois University Conversion System) pile stormwater runoff
- IUCS Truck wheel wash
- Landfill Stormwater runoff
- Gypsum storage Stormwater runoff (not currently discharged through Outfall No. 007)

To determine if any streams can be discharged without treatment, CH2M HILL performed the following evaluations; however, in all cases one or more parameters exceeded the permit limits:

- Compared historical Petersburg Outfall No. 007 water quality, and various combinations of the individual streams that make up the flow to Petersburg Outfall No. 007, to projected White River limits to determine if relocating the discharge would comply with the limits.
- Compared the historical Petersburg Outfall No. 007 individual streams water quality and/or combination of the individual streams that make up the flow to Petersburg Outfall No. 007 (IUCS runoff, wheel wash, landfill runoff, and gypsum pile runoff) against the Lick Creek Outfall No. 007 limits to determine if any of the individual and/or combination of streams would comply with the limits.

Since treatment or other management options would be required for any of the discharge options, CH2M HILL and IPL developed options for each stream as well as combinations of streams, summarized in Table 7. The costs and risks (including risk of non-compliant discharge) were identified for these different management options for each stream.

Our preliminary recommended management approach for each stream is described at the end of this memo.

Historical Petersburg Outfall No. 007 Discharge Water Quality Compared to Lick Creek No. 007 Final Limits

The final Water Quality and Technology Based Effluent Limits for discharge to Lick Creek in the current permit are shown in Table 1. Historical effluent water quality, per Discharge Monitoring Report (DMR) data from January 2010 to August 2013, shows that several parameters exceeded the limits for discharge to Outfall No. 007 to Lick Creek at various times (shown in Table 2). Therefore, treatment and/or management options would be necessary in order to comply with the final NPDES permit limits in order to comply.

TABLE 1
Final Limits in Current Permit for Discharge to Lick Creek Outfall No. 007, Effective 2017

Parameter	Monthly Average	Daily Maximum
B, mg/L	8.3	14
Cd, mg/L	0.002	0.0035
Cu, mg/L	M&R	M&R
Pb, mg/L	0.0085	0.015
Hg, ng/L	12	20
Ni, mg/L	M&R	M&R
Se, mg/L	0.033	0.057
Sulfate, mg/L	1500	2600
Cr, mg/L	M&R	M&R
Fe, mg/L	M&R	M&R
Zn, mg/L	M&R	M&R

M&R (Monitor and Report) only: NH_4 as N, Chloride, Mn, TP as PO_4, CN, As, F

mg/L = milligrams per liter

TABLE 2
Outfall No. 007 Compliance Data (January 2010 through August 2013)

Parameter	New Limit		Average	Minimum	Maximum	Count	# over limit
Flow	Monthly Avg	M&R	0.23	0.12	0.46	44	NA
(MGD)	Daily Max		0.24	0.12	0.73	44	NA
Flow	Monthly Avg	M&R	159	83	321	44	NA
(gpm)	Daily Max		167	833	507	44	NA
	Monthly Avg	--	7.54	6.94	7.77	44	0
pH	Daily Min/Max	6-9	7.66	7.43	7.91	44	0
Oil/Grease	Monthly Avg	15	5.0	5.0	6.6	44	0
(mg/L)	Daily Max	20	5.1	5.0	8.1	54	0
TSS	Monthly Avg	30	11	3	22	44	0
(mg/L)	Daily Max	100	12	2	32	55	0
Sulfate	Monthly Avg	1500	1216	420	1700	22	3
(mg/L)	Daily Max	2600	1145	340	1700	33	0
Mercury	Monthly Avg	12	17	5	89	20	9
(ng/L)	Daily Max	20	15	5	89	26	4
Boron	Monthly Avg	8.3	2.7	1.5	3.5	11	0[1]
(mg/L)	Daily Max	14	2.7	1.5	3.7	22	0[1]
Cadmium	Monthly Avg	0.002	<0.01	<0.002[2]	<0.01[2]	11	0[2]
(mg/L)	Daily Max	0.0035	<0.01	<0.002[2]	<0.01[2]	22	0[2]
Lead	Monthly Avg	0.0085	<0.01	<0.0085[2]	<0.01[2]	11	0[2]
(mg/L)	Daily Max	0.015	<0.01	<0.0085[2]	<0.01[2]	22	0[2]
Selenium	Monthly Avg	0.033	0.01	0.006	0.02	11	0
(mg/L)	Daily Max	0.057	0.01	0.004	0.02	22	0

Notes: M&R = Monitor and Report; NA = Not Applicable

1. Some samples collected in 2009 for boron were above limit. Three out of 12 samples in 2009 were above discharge limits with an average concentration of 10 mg/L.
2. Four of the sample results received by CH2M HILL were 0.01 mg/L. CH2M HILL assumed the actual result was <0.01 mg/L in this table.

Historical Petersburg Outfall No. 007 Discharge Water Quality Compared to Projected White River Limits

Historical Outfall No. 007 effluent quality values were compared to White River limits to determine if relocating the discharge would aid in complying with limits. The White River discharge limits were projected based on available calculation methods. This comparison (summarized in Table 3) shows that cadmium and mercury in the Outfall No. 007 discharge would have reasonable potential to exceed limits if discharged to the White River. Therefore, relocating Outfall No. 007 to the White River would require additional management (treatment, reuse, or elimination) to comply with these limits.

TABLE 3
Pollutants with Reasonable Potential to Exceed Effluent Limits for Discharge of Outfall No. 007 to the White River

Parameter	Monthly Average Comparison			Daily Maximum Comparison			Reasonable Potential to Exceed?
	Monthly Average PEQ[1] (µg/L)	Monthly Average WQBEL[2] (µg/L)	PEQ >[1] WQBEL?	Daily Maximum PEQ[1] (µg/L)	Daily Maximum WQBEL[1,2] (µg/L)	PEQ >[1] WQBEL?	
Cadmium	13	11	Yes	11	20	No	Yes
Mercury	0.134	0.012	Yes	0.134	0.020	Yes	Yes

1. PEQ = Projected Effluent Quality determined by procedures in 327 IAC 5-2-11.5
2. Water Quality Based Effluent Limits (WQBELs) based on the 2-year Maximum Monthly Average flow (2011-2012) for Outfall No. 007 of 0.37 cfs (0.24 MGD) as set forth by 327 IAC 5-2-11.4(a)(9)
µg/L = micrograms per liter

Evaluate Discharging Wastewater Streams Individually to Petersburg Outfall No. 007

IPL (with GE and CH2M HILL) collected samples of each of the individual streams that discharge to Outfall No. 007 in order to evaluate which streams may require treatment. The average and maximum concentrations of pollutants in each of the wastewater streams that contribute to Outfall No. 007 are presented with the monthly average limits for Lick Creek (shown in Table 4). The pollutants presented in this table are only those that have the potential to exceed the limits based on historical results.

Wastewater flows from the IUCS runoff and wheel wash have the greatest risk of noncompliance. Sample measurements from these wastewater streams exceed the limits for nearly all of the pollutants that have limits in the permit.

Initial sampling of the landfill runoff suggested that it may comply with the current limits for Outfall No. 007. However, the extended sampling for the landfill runoff determined that sulfate is greater than half the permit limit and two mercury samples (both in August 2013) were above the limits. Mercury concentrations in the Outfall No. 007 samples in August 2013 were about half of the landfill runoff values. In late July and early August, the plant dug out a small section of the runoff ditch and repaired riprap and sediment control structures, which is a common activity when addressing erosion issues. Sampling occurred on August 1 and 6, 2013. Therefore, this work may have stirred up sediments or solids which affected the sample results which IPL anticipates when addressing future erosion issues. Sulfate concentrations are greater than half the limit but have not exceeded the limit for the monitoring period. Therefore, there is a moderate risk that there may be future non-compliance with the NPDES permit based on historical erosion and associated run-off issues.

Petersburg Station has had to store some of its produced gypsum outside on an intermittent basis. This has resulted from two supply-and-demand situations. During part of the year, the station's supply of gypsum is less than the demand of the main customer (USG). Therefore, a pile is maintained to help provide continuity of sales during these times. This pile is larger than can be stored under the existing cover. During other periods of the year, more gypsum is produced then the current customers demand, hence gypsum is stored until demand catches up. The samples from the gypsum pile runoff that were analyzed for lead and selenium exceed the monthly average limit for discharge to Lick Creek. In addition, the sulfate concentrations are greater than one-half of the permit limit and also pose a compliance risk.

Therefore, each of the streams would most likely require treatment if discharge through Outfall No. 007 is continued.

TABLE 4
Parameters of Compliance Risk in 007 Water Streams to Lick Creek

Parameter	Units	Lick Creek Monthly Average Limit	IUCS Runoff				Wheel Wash				Landfill Runoff				Gypsum Pile Runoff			
			Average	Maximum	# samples	# samples above limit	Average	Maximum	# samples	# samples above limit	Average	Maximum	# samples	# samples above limit	Average	Maximum	# samples	# samples above limit
Boron	mg/L	8.3	33	57	3	3	4	9	3	1	2	3	20	0	-	-	0	0
Cadmium	mg/L	0.002	0.01	0.02	3	1	0.01	0.02	3	1	ND	ND	20	0	ND	ND	9	0
Lead	mg/L	0.0085	0.1	0.3	3	2	0.1	0.2	3	3	ND	ND	20	0	0.02	0.09	9	1
Mercury	ng/L	12	1481	2570	3	3	1960	5250	3	3	13*	25*	12	4	-	-	0	0
Selenium	ug/L	33	101	173	3	3	40	81	3	1	6**	14**	19	0	52	280	9	0
Sulfur, as SO_4	mg/L	1500	1507	1700	3	2	310	392	3	0	1083	1300	23	0	928	1500	9	0

Note: Values in pink are above Lick Creek limit; values in green are greater than one-half Lick Creek limit so represent some risk.
ND = Not Detected
- = Not analyzed
mg/L = milligrams per liter; ug/L = micrograms per liter; ng/L = nanograms per liter
*Average landfill of 12 ng/L does not include one result (from 10/15/2012) of <100 ng/L; as all other results are well less than 100 ng/L.
**Average landfill runoff value of 6 µg/L does not include one result (from 5/9/2013) of <50 µg/L as all other results are well less than 50 µg/L.
Source: Dates of sampling for each stream are provided in Table 6.

Discharging Combinations of Streams to Petersburg Outfall No. 007 Compared against White River Limits

Several combinations of individual streams that make up Outfall No. 007 were compared against the projected White River discharge limits to determine if any of the individual streams could be discharged, while managing the others. For each discharge option, wastewater quality was estimated and compared to permit limits in order to determine which parameters require treatment. One or more parameters were exceeded for each combination of stream discharges (summarized in Table 5). For all flow combinations, the risks include:

- Mercury presents the greatest risk. In some combinations, copper and iron also needed to be reduced to meet limits. Treatment processes for mercury typically entail chemical precipitation followed by settling. Other cationic metals (such as iron and copper) typically are well removed by treatment used for mercury, and hence do not represent a need for additional treatment.
- It should be noted that Table 5 presents parameters with compliance risks if flue gas desulfurization (FGD) water is managed by zero liquid discharge (ZLD). If FGD water is treated and combined with Outfall No. 007 for discharge, it will also add significant risk of boron non-compliance, regardless of which Outfall No. 007 streams are discharged along with the FGD water. On days with heavy runoff flows, boron would be at lower concentrations but runoff would be only intermittent. Table 5 also assumes that bottom ash is not discharged; if it is discharged, then boron compliance risk is low. However, there is a moderate risk that the effluent limitation guidelines (ELG) will ban discharge of bottom ash transport water from units over 400 megawatts (MW), which would preclude this approach.
- At the time of this review, U.S. Environmental Protection Agency (EPA) Region 5 has not approved any relaxation of permit limits associated with relocation of outfall(s) to the White River (i.e., antibacksliding issue pursuant to Section 402(o) of the Clean Water Act or other potential permitting obstacles). If antibacksliding applies and

recalculation of the final permit limits is not allowed, this portion of the compliance limits and alternatives evaluation would not be an option.

Based on this information, CH2M HILL evaluated different management options for the flows that make up the current Outfall No. 007 discharge.

TABLE 5

Individual Streams to Outfall No. 007 Compared against White River Outfall No. 007 Limits, If Discharged with the Other Water Stream, Assumes FGD Managed by ZLD, and no Ash Water Discharge

Outfall No. 007 Stream(s) to White River with Other Water Group	Estimated Effluent Concentration > ½ Projected White River Limit On Days of Design Storm, Not Giving Credit for Settling out of Particulate Metals in Outfall No. 007 Waters[1,2]
1a - IUCS & wheel wash with Other Water Group	Copper, Iron, Mercury
2b – Landfill runoff with Other Water Group	Mercury
3b – IUCS & wheel wash and Landfill runoff with Other Water Group	Iron, Mercury
4b – IUCS & wheel wash and Landfill and gypsum runoff with Other Water Group	Iron, Mercury

[1] This is a conservative assumption. Since total suspended solids (TSS) removal (settling) is needed, a significant portion of the particulate metals should also be removed. Iron and mercury are primarily particulate in the Outfall No. 007 water samples used in modeling. Copper had mixed results regarding percent particulate, and hence will have some removal. Boron and sulfate are likely not removed by simply settling.

[2] If the sulfate limit to the White River is set as in our calculations, and assuming FGD water is managed by ZLD it appears th at the Outfall No. 007 waters would be below the sulfate limit to the White River. However, if IDEM interprets antibacksliding as requiring a White River outfall to have the same 1,500 mg/L sulfate limit as in current permit for Lick Creek, this approach would represent a moderate to significant compliance risk during those potential periods when other water is not flowing (outages) and diluting the stormwater runoff. Samples of landfill runoff have had 900 to 1,300 mg/L sulfate; IUCS runoff samples had 1,100 to 1,700 mg/L sulfate.

Evaluation of Management Options for Outfall No. 007 Streams

Setting Design Basis

For the purpose of calculating effluent limits and projected effluent quality in this TM, flow rates from each of the Outfall No. 007 wastewater streams were estimated. Most of the flow to Outfall No. 007 is stormwater runoff, and therefore the flow is dictated by precipitation. Maximum flows were estimated using the drainage area and a 25-year/ 24-hour storm event, which is 5.6 inches per the Natural Resources Conservation Service. Drainage areas were determined based on the Stormwater Pollution Prevention Plan drawing. The design basis for the wastewater streams flowing to Outfall No. 007 are shown in Table 6.

TABLE 6
Basis of Design for Outfall No. 007 Flows

	Source	Area of rainfall affected (acres)	Flow from 25-yr, 24-hr storm in 1 day (gpd)	Flow from 25-yr, 24-hr storm if bled back over 30-day period (gpd)	Water Quality Basis
IUCS	Stormwater	5	724,000	31,300	IUCS runoff sampled by CH2M HILL 10/2/12, 11/5/12, and 11/13/12.
Wheel wash	Process water	N/A	7,200 [5 gpm]		Wheel wash sampled by CH2M HILL 10/3/12, 11/5/12, and 11/13/12.
Landfill	Stormwater	40	5,687,000	189,600	Landfill runoff sampled by CH2M HILL 10/2/12, 10/15/12, and 10/30/12, and additional sampling data from January - December 2013.
Outdoor Gypsum Area	Stormwater	2.5	362,000	12,100	Assumed water quality would be comparable to NPDES Permit Stormwater Sample Point No. 31, which receives runoff from gypsum storage area. Nine samples from 2006-2013.
Total		**47**	**6,780,000**	**233,000**	

Key assumptions made in the evaluation include:

- At the time of this review, EPA Region 5 has not approved any relaxation of permit limits associated with relocation of outfall(s) to the White River (i.e., antibacksliding issue pursuant to Section 402(o) of the Clean Water Act or other potential permitting obstacles). If this is not allowed, some of the compliance limits and alternatives evaluation presented in this TM would change, such as sulfate as noted in Table 5.
- Covering the IUCS pile will eliminate the wheel wash wastewater stream.
- Fly Ash Handling will be dry.
- Reclaim options were evaluated using the assumption that the capacity to reuse water in the FGD system through Unit 2, and either the #4 or #5 ball mill, which will be dedicated to Unit 4, and that the flow is limited to 620 gpm. Other water uses in the FGD system (such as the mist eliminators) require higher quality water, and no fresh water added back to the scrubber is available for replacement. The current plan to recycle FGD water will send 475 gpm of FGD water after solids removal back to the FGD systems. This leaves 145 gpm or 209,000 gpd capacity, on average, for use of reclaimed runoff water.
- A key assumption in evaluating treatment and reuse was the amount of time over which peak flows could be “bled back” for treatment or use. CH2M HILL assumed 30 days to bleed back a 5.6-inch storm. This rate is linearly related to the amount of runoff; for example, half the rainfall (2.8 inches), which presumably would occur more often, could be bled back in half the time (15 days). If large storm events occur more frequently, this would represent a risk to the compliance strategy. Sizing of equalization storage is a cost/risk balance. Risk could be lowered by building larger storage than what has been assumed in the cost estimates presented in Table 7.
- The proposed ELG is not anticipated to impact Outfall No. 007 water, unless the landfill runoff is regulated as landfill leachate. If this is the case, under the proposed rule it will be subject to existing source limits on total suspended solids (TSS), oil and grease, and pH, for which historical effluent data is in compliance. Compliance of the relocated 007 to the White River would be based on the combined formula calculation pursuant to 40 CFR 403.6(e).

Define and Evaluate Alternatives

The following options were considered initially, but not considered further for the following reasons:

- Treatment by pond-based treatment and discharge to White River. Both treating with only setting and treating by enhanced pond treatment were considered. Both would have similar costs as both need large settling areas (pond or large clarifier) and chemical feed systems. There is a high risk that the final coal combustion residual (CCR) rule will require surface impoundments (ponds) that receive runoff from CCR wastes (such as the 007 flows) to be phased out, or retrofitted (composite liner, groundwater monitoring, etc.) as early as 2019.
- Co-treat with FGD water by biological treatment, and discharge to White River. There is a high risk that the ELG anti-circumvention provisions will not allow treating anything except leachate with FGD water.

Therefore, each of the Outfall No. 007 water streams was evaluated for the following compliance options and the results are presented in Table 7:

- Eliminating source of runoff contamination;
- Treatment (co-treat or treat stream alone) and discharge; and/or
- Reuse in the plant.

Cost-risk decision grids for these options are presented in Figure 1, Figure 2, and Figure 3.

Preliminary Recommendations and Observations

Preliminary recommendations and observations are summarized below, in order of preference by stream. Some lowest-cost options may not be feasible or preferable from a regulatory or IPL policy perspective, and some may carry risk of IDEM interpretation differing from those used in this memorandum.

1) Gypsum pile runoff.
    a. Source elimination by off-site storage. The plan currently being pursued by Dana Meier of IPL for eliminating the outdoor onsite storage of gypsum by setting up offsite storage is a favorable alternative of this stream. However, there is no confirmed approval of this plan in the IPL budget or contracts in place at the time of this evaluation.
    b. Source elimination by covering pile - Covering the gypsum pile may be preferred by IPL because of general stormwater management requirements in permit Part I.D.4.[3] However, it is a higher cost than other possible options, hence a cost/risk evaluation will be required in order to make selection.
2) Landfill runoff. The cost of a cover over the Poz-o-Tec is included in the NPDES project cost estimate at this time.
    a. Source elimination by soil cover. Covering the existing landfill poz-o-tec with clay-type soil and/or membrane is a lower-cost approach than managing the contaminated runoff. If possible, using soil and/or membrane in a new

[3] From current NPDES permit:
"4. Technology-Based Effluent Limits (BPT/BAT/BCT): Non- Numeric Effluent Limits
a. Minimize Exposure. Minimize the exposure of raw, final, or waste materials to rain, snow, snowmelt, and runoff. To the extent technologically available and economically practicable and achievable, either locate industrial materials and activities inside or protect them with storm resistant coverings in order to minimize exposure to rain, snow, snowmelt, and runoff (although significant enlargement of impervious surface area is not recommended). In minimizing exposure, pay particular attention to the following areas:
Loading and unloading areas: locate in roofed or covered areas where feasible; ….
Note: Industrial materials do not need to be enclosed or covered if stormwater runoff from affected areas will not be discharged to receiving waters. …..

f. Management of Runoff
Divert, infiltrate, reuse, contain or otherwise reduce stormwater runoff, to minimize pollutants in the discharge …..

p. Miscellaneous Loading and Unloading Areas
Minimize contamination of precipitation or surface runoff from loading and unloading areas. Consider covering the loading area; grading, berming, or curbing around the loading area to divert run-on; locating the loading and unloading equipment and vehicles so that leaks are contained in existing containment and flow diversion systems; or equivalent procedures."

landfill area rather than poz-o-tec will help avoid creating new contaminated stormwater and minimize risk associated with future ELG and CCR rules.

3) IUCS and truck wheel wash.

   a. Source elimination by covering pile - Covering the IUCS and/or gypsum pile may be preferred by IPL because of general stormwater management requirements in permit Part I.D.4.[4] However, it is a higher cost than other possible options, hence a cost/risk evaluation will be required in order to make selection.

   b. Reuse. Reuse of runoff is a lower cost than treating if it is necessary to combine with FGD wastewater treatment, as both reuse and treatment approaches require storage to equalize storm flows and the treatment option also requires increasing size of treatment system components.

The following options were considered for each stream, but were higher cost than primary or secondary options:

- Co-treat with FGD water by ZLD evaporator. CH2M HILL does not envision a likely scenario where Outfall No. 007 water would be treated by ZLD (evaporation) because the streams should be clean enough to recycle back to FGD makeup (a different option) without treatment. However, by treating the water through the evaporator it would be available for reuse in uses other than the ball mills. Therefore, if capacity for reuse becomes an issue, this approach provides an alternative treat-and-reuse option. The **IUCS** water, after equalization, would be a small flow (31,300 gpd) and would have little impact on the FGD ZLD treatment option (currently sized to receive over 800,000 gpd). The gypsum pile, after equalization, is 12,100 gpd and would also represent a small increase is evaporator sizing.
- Treat with stand-alone tank-based physical/chemical treatment and discharge to White River[5]. This option would add an additional treatment system, and has higher costs and operating complexity.

Recommended Compliance Strategy

The recommended alternatives were determined based on cost and risk. The project team also considered stormwater-management requirements of the current permit and potential requirements in future permits.

Gypsum Pile Runoff

The recommended compliance strategy is source elimination by covering the outside gypsum pile. This will eliminate runoff from the outdoor gypsum pile. This will also help with meeting the general stormwater non-numeric requirements in permit Part I.D.4

[4] From current NPDES permit:
"4. Technology-Based Effluent Limits (BPT/BAT/BCT): Non- Numeric Effluent Limits
a. Minimize Exposure. Minimize the exposure of raw, final, or waste materials to rain, snow, snowmelt, and runoff. To the extent technologically available and economically practicable and achievable, either locate industrial materials and activities inside or protect them with storm resistant coverings in order to minimize exposure to rain, snow, snowmelt, and runoff (although significant enlargement of impervious surface area is not recommended). In minimizing exposure, pay particular attention to the following areas:
Loading and unloading areas: locate in roofed or covered areas where feasible; ....
Note: Industrial materials do not need to be enclosed or covered if stormwater runoff from affected areas will not be discharged to receiving waters. .....

f. Management of Runoff
Divert, infiltrate, reuse, contain or otherwise reduce stormwater runoff, to minimize pollutants in the discharge .....

p. Miscellaneous Loading and Unloading Areas
Minimize contamination of precipitation or surface runoff from loading and unloading areas. Consider covering the loading area; grading, berming, or curbing around the loading area to divert run-on; locating the loading and unloading equipment and vehicles so that leaks are contained in existing containment and flow diversion systems; or equivalent procedures."

[5] If the sulfate limit to the White River is set as in our calculations, and assuming FGD water is managed by ZLD, it appears that the Outfall No. 007 waters could be treated and then discharged to the White River. However, if IDEM interprets antibacksliding as requiring a White River outfall to have the same 1,500 mg/L sulfate limit as in current permit for Lick Creek, this approach would represent a moderate to significant compliance risk during those potential periods when other water is not flowing (outages) and diluting the stormwater runoff (samples of landfill runoff have had 900 to 1,300 mg/L sulfate; IUCS runoff samples had 1,100 to 1,700 mg/L sulfate).

Landfill Runoff

Mercury results in August and October 2013 were higher than previous results for Outfall No. 007 concentrations. The plant did excavate a drainage ditch and repaired riprap and sediment control structures in late July/early August 2013, which may have affected mercury results and is anticipated with future maintenance work. Sulfate concentrations are greater than half the limit but have not exceeded the limit for the monitoring period. Therefore, there is a moderate risk that there may be future non-compliance with the NPDES permit based on historical erosion and associated run-off issues.

The risk of non-compliance necessitates managing the runoff; therefore, the recommended option is covering the existing landfill Poz-o-Tec cover. Covering is a lower-cost approach than managing the contaminated runoff. If possible, using soil and/or membrane in a new landfill area rather than Poz-o-Tec will help avoid creating new contaminated stormwater and minimize risk associated with future ELG and CCR rules. Several cover options exist, including clay-type soil and/or membrane or a chemical additive spray. The cover choice would need to be determined. An allowance is included in the NPDES compliance project cost estimate. The actual covering will be done under separate contract, not under the wastewater treatment system EPC contract.

IUCS and Truck Wheel Wash

The IUCS pile is a source of boron above discharge limits so it must be managed (eliminated, treated or reused). The recommended compliance strategy is source elimination by covering the IUCS pile. Covering the IUCS pile is preferred because it will reduce or eliminate tracking solids away from the pile that could become stormwater contaminants, and it will also help with meeting the general stormwater non-numeric requirements in permit Part I.D.4.[6]

[6] From current NPDES permit:
"4. Technology-Based Effluent Limits (BPT/BAT/BCT): Non- Numeric Effluent Limits

a. Minimize Exposure. Minimize the exposure of raw, final, or waste materials to rain, snow, snowmelt, and runoff. To the extent technologically available and economically practicable and achievable, either locate industrial materials and activities inside or protect them with storm resistant coverings in order to minimize exposure to rain, snow, snowmelt, and runoff (although significant enlargement of impervious surface area is not recommended). In minimizing exposure, pay particular attention to the following areas:

Loading and unloading areas: locate in roofed or covered areas where feasible; ….

Note: Industrial materials do not need to be enclosed or covered if stormwater runoff from affected areas will not be discharged to receiving waters. …..

f. Management of Runoff
Divert, infiltrate, reuse, contain or otherwise reduce stormwater runoff, to minimize pollutants in the discharge …..

p. Miscellaneous Loading and Unloading Areas
Minimize contamination of precipitation or surface runoff from loading and unloading areas. Consider covering the loading area; grading, berming, or curbing around the loading area to divert run-on; locating the loading and unloading equipment and vehicles so that leaks are contained in existing containment and flow diversion systems; or equivalent procedures.

TABLE 7

007 Alternative Evaluation Summary

	IUCS and Wheel wash			Landfill Runoff			New Gypsum Area		
	Description	**$*** **	**Risks**	**Description**	**$*** **	**Risks**	**Description**	**$*** **	**Risks**
Source Elimination	Building over IUCS to eliminate IUCS pile runoff and truck wheel wash. Assume 200' x 300' (1.4 acres).	Capital: $6.6M O&M: Low	**Total Risk Score = 1** 1 – Compliance. Should result in runoff being below limits (or no limits)	Liner over current poz-o-tec. Assume $70K/ac total direct costs (plus roughly 90% for adders such as profit, engineering, contingency), 32 acres. (Assumes costs of covering new landfill with soil to be outside this ww project)	Capital: $4.4M O&M: Low	**Total Risk Score = 1** 1 – Compliance. Should result in runoff being below limits (or no limits)	Cover pile - Building over gypsum (assume 2 acres)	Capital = $3.6M O&M: Low	**Total Risk Score = 1** 1 – Compliance. Should result in runoff being below limits (or no limits)
							Store offsite to eliminate pile. Establish an agreement with a nearby firm for offsite storage; IPL could retrieve it as needed to sell.	Capital: low. Ongoing: A savings versus disposal during periods when main demand does not meet supply. Assumed net cost to manage: $100K/yr	**Total Risk Score = 3** 2 – Have contracted for only part of excess currently (Sept 2013), but Dana working to get rest. 1 – Become dependent on outside contractor
							Don't store the material and return it to mines	Capital: None? On-going: ~$300,000/yr for disposal instead of sale. (See Notes)	**Total Risk Score = 1** 1 – Become dependent on outside contractor
							Offsite disposal to landfill with potential to reuse once contracts confirmed in the future (similar to HSS).	Capital: None? On-going: Would depend on ability to re-sell	**Total Risk Score = 2** 1 – Don't have contracted currently (Sept 2013) 1 – Become dependent on outside contractor
							Sub-alternative: Storage in a pit in NW corner of landfill, and then pump, equalize, treat, discharge; or pump, equalize, reuse.	Cost is equal to treatment or reuse options, plus $500K to line and $1.7M to add leachate system to pond.	**Total Risk Score = 3.5+** 3.5 - There are potential RCRA and final CCR rule concerns/risks with storage in/beside the landfill. Plus risk of treatment or reuse, depending on which is used.
Reuse (in FGD makeup water)*	Curb around IUCS pile (to segregate from run-on), new sump, pump, pipes. Send water to a new equalization tank**** (one 1,000,000-gallon) if FGD by bio from where it can be pumped to FGD Reclaim Tank. Note – If FGD ZLD option chosen, could route runoff to FGD Solids-Removal Effluent tank and make that tank bigger, rather than building new EQ tank. This would lower cost.	Capital: $2.5M O&M: Low	**Total Risk Score = 4** 2 – There is a limited amount of water that can be used, and would need to plan for contingency if large rainfall when Unit 4 not on-line and available to evaporate water 2 – Compliance: Covering the IUCS and/or gypsum pile may be preferred by IPL due to general non-numeric stormwater management requirements (e.g., minimization of	Same as IUCS, though no curb needed. Cost assuming 6,000,000-gallon tank to equalize flow.	Capital: $6.6M O&M: $100K/ir	**Total Risk Score = 6** Same as IUCS (4) + 2 – Landfill flow equalized over 30 day bleed back target is 190,000 gpd. This is nearly all the reuse capacity (209,000 gpd), and would not leave capacity for IUCS and gypsum runoff. Therefore, would need even larger tank or have greater risk of insufficient capacity.	Same as IUCS. Cost assuming 500,000-gallon tank.****	Capital: $1.9M O&M: $100K/yr	**Total Risk Score = 4** Same as IUCS (4)

TABLE 7

007 Alternative Evaluation Summary

	IUCS and Wheel wash			Landfill Runoff			New Gypsum Area		
	Description	**$*** **	**Risks**	**Description**	**$*** **	**Risks**	**Description**	**$*** **	**Risks**
			exposure, erosion control), in permit Part I.D.4**						
Treat & Discharge: Co-Treat with FGD WW ZLD	Curb around IUCS pile, new sump, pump, pipes, to send water to a new EQ tank at WWTP, from where it has bled to the FGD Evaporator Feed Tank. Increases size of Evaporator roughly 25%.	Capital: $4.7M O&M: $780K/yr	**Total Risk Score = 2** 2 – Compliance: Covering the IUCS and/or gypsum pile may be preferred by IPL due to general Stormwater management requirements in permit Part I.D.4**	Not considered, because runoff flow too high and too clean to consider treatment through ZLD.			Same as IUCS, increases size of Softening and Evaporator roughly 10%.	Capital: $2.7M O&M: $450K/yr	**Total Risk Score = 2** Same as IUCS (2)
Treat & Discharge with new P/C Treatment System	Curb around IUCS pile, New treatment system: EQ tank****, chemical feed, clarifier. Use package plant since equalized flow very small.	Capital: $3.4M O&M: $220K/yr	**Total Risk Score = 5** 3 – Compliance risk of meeting low limits on trace metals. And risk of IDEM using anti-backsliding and setting low sulfate limit. 2 – Compliance: Covering the IUCS and/or gypsum pile may be preferred by IPL due to general stormwater management requirements in permit Part I.D.4**	Same as IUCS	Capital: $8.9M O&M: $330K/yr	**Total Risk Score = 5** Same as IUCS (5)		Capital: $2.7M O&M: $220K/yr	**Total Risk Score = 5** Same as IUCS (5)

*- Reuse options will need to consider capacity for reuse. Currently considering ball mills which can take 620 gpm, but assuming that 475 gpm of that will be used by returning FGD water after solids-removal.

** - Issues that could impact any plan that has onsite storage with treatment and discharge include:

- Numeric stormwater limits might be included during the next permit cycle.
- Discharge of the runoff might trigger anti-backsliding rules.
- Pollutant concentrations may drive new/more stringent water quality based effluent limits.

*** - Cost estimates are very rough at this time, as little engineering has been done. Costs are considered Class 5 estimates with +100/-50 percent accuracy.

**** - The new treatment system option could be made lower cost by using the currently out-of-service Thickener ("U4) or U3 thickener if U4 is put back into service for equalization and possibly clarification of runoff, rather than building a new equalization tank. However, this would reduce the operational flexibility of the overall compliance strategy, as that thickener is planned to be used as temporary storage of tank dumps.

P/C = physical/chemical

<u>Notes on gypsum</u>
Returning gypsum to the mines means higher cost to IPL then selling for wallboard or sending for agricultural use.

- Assuming 100,000 tons/year is under consideration related to outdoor gypsum pile, as this is roughly the difference between current supply and demand, though this varies significantly from year to year.
- Agricultural gypsum marketer with storage area available near Petersburg. Targeting $2-3/ ton cost for IPL (first year costs could be higher depending on costs to establish the stockpile and market development). When sell to main customers get $0.50 to $1.00 per ton. Current option for mine disposal right now (costs $5.50-6.00/ton– transport and place).
- Therefore, cost difference of storing onsite so could sell to new agricultural marketer versus disposal in mine is estimated roughly $3/ton. Or $300,000/year.

Risks areas include: compliance, risk of schedule compliance or IURC rejection as cost recovery, adaptability to future regulations, A risk score was given in each risk area, if no risk score shown for an area it is not viewed as risk:
4 = high risk
3 = medium risk
2 = moderate risk
1 = low risk

Cost-risk decision grids for the options in **Table 7** are shown in **Figures 1 through 3**. Risk scores are summation of the risks shown in Table 7.

FIGURE 1
Decision Grid – IUCS Runoff and Wheel Wash Options

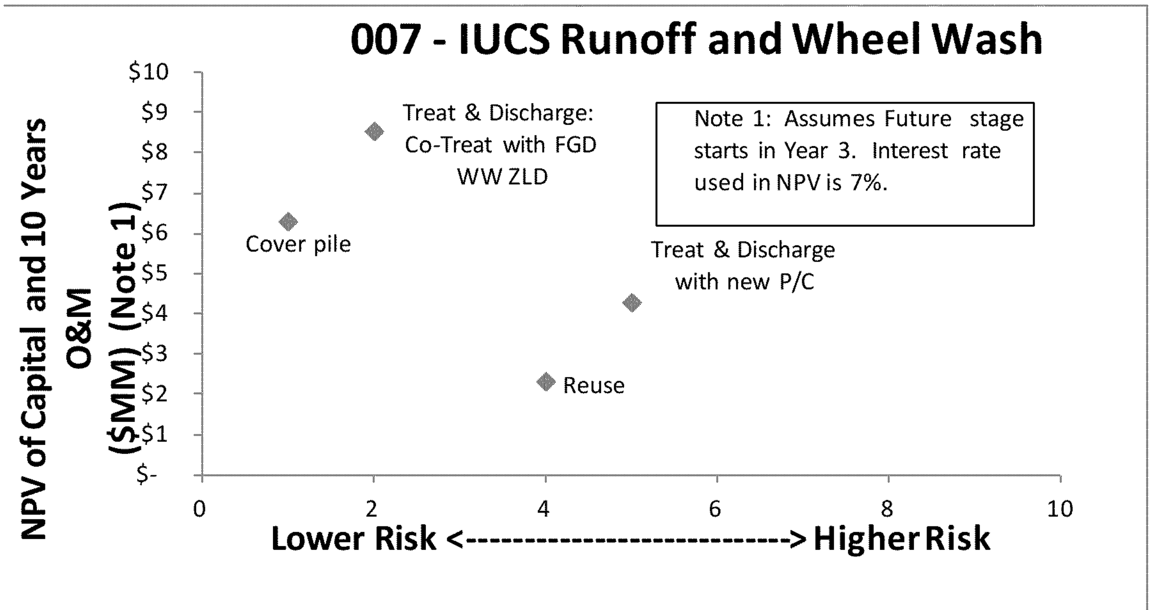


FIGURE 2
Decision Grid – Landfill Runoff Options

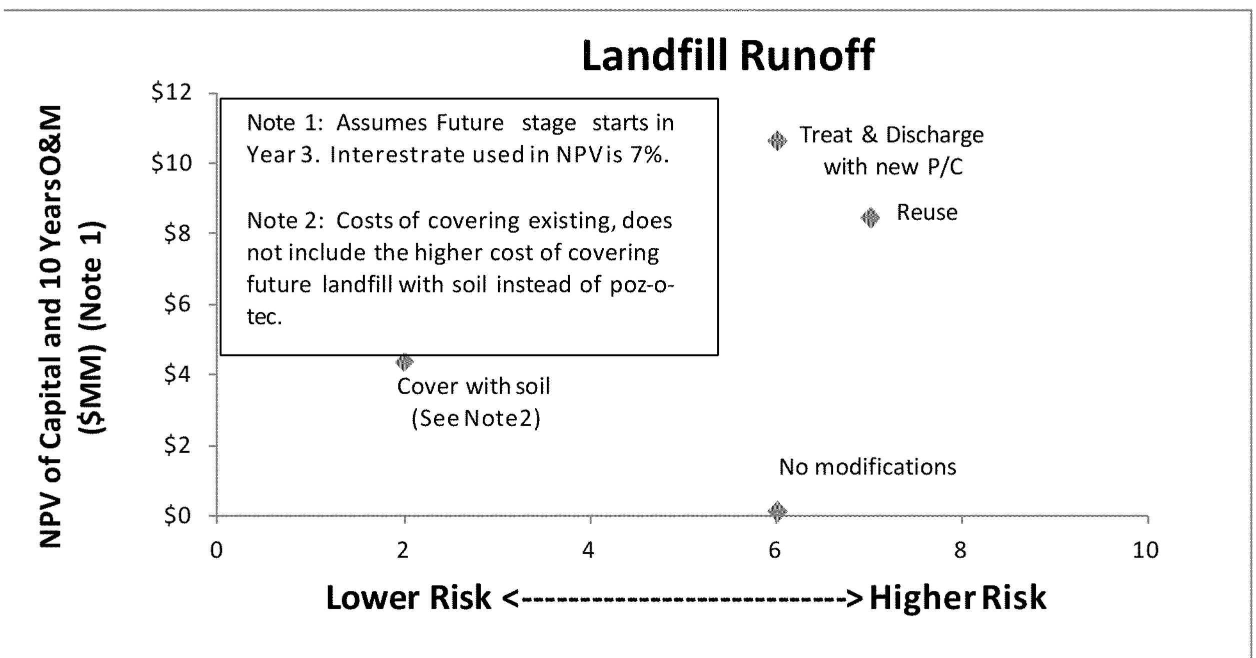
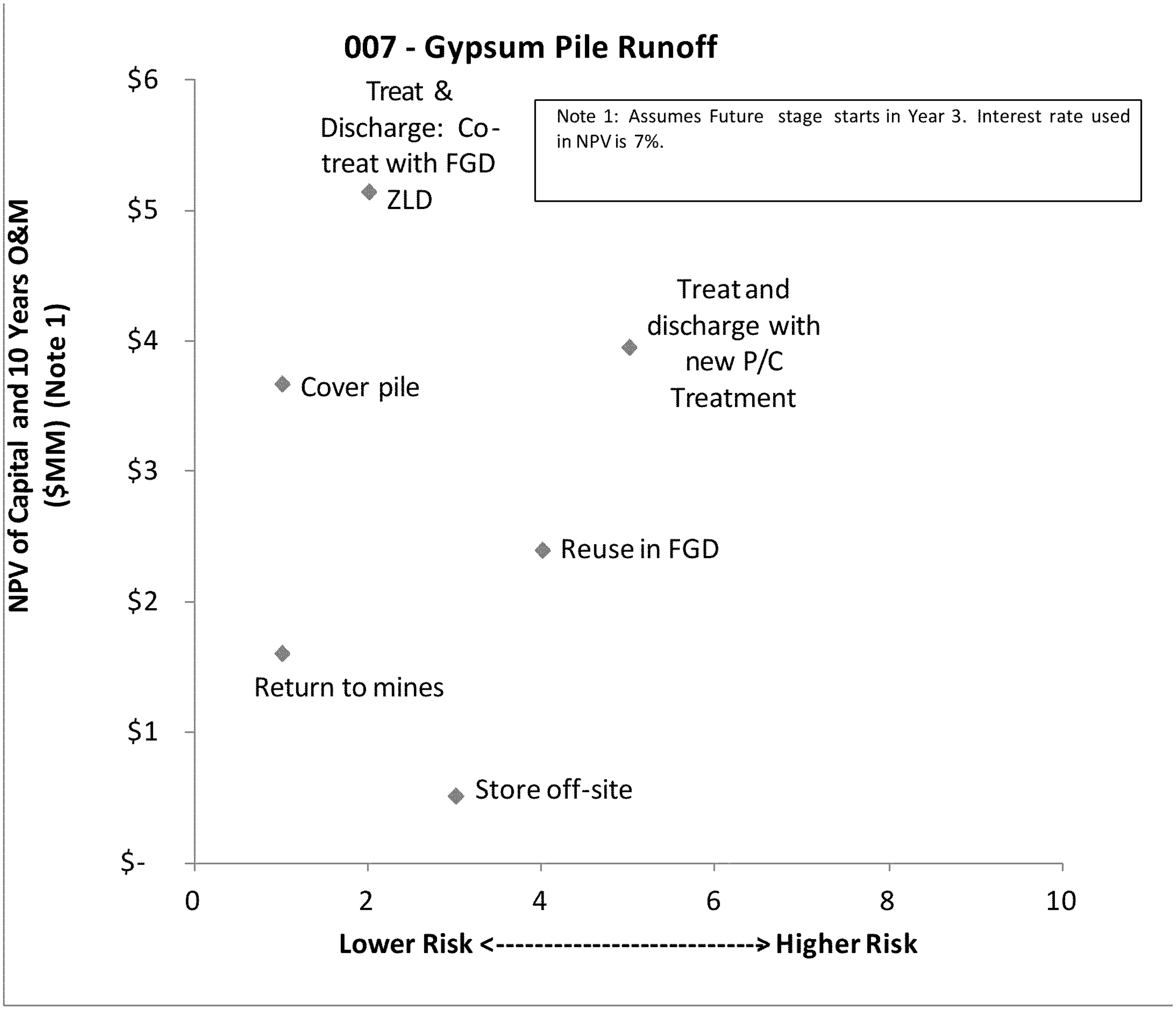


FIGURE 3

Decision Grid – Gypsum Pile Runoff Options

Not shown: storage at landfill for later reuse, as cost unknown (dependent on ability to reuse)

Not shown: use pond on landfill. Cost and risk from that element of compliance strategy would be added to cost of associated management (treatment or reuse) as described in Table 7.



Appendix E
Compliance Strategy Options for Bottom Ash Waters

Indianapolis Power & Light Company (IPL) – Compliance Strategy Options for Bottom Ash Waters

PREPARED FOR: David Kehres/IPL, Nysa Hogue/IPL, Greg Daeger/IPL, David Heger/IPL

PREPARED BY: CH2M HILL

DATE: February 7, 2014

This memorandum has been prepared to support decision-making on the compliance strategy for bottom ash waters at the Harding Street and Petersburg stations.

Introduction

A strategy for bottom ash sluice waters[7] is to treat the water by physical settling of total suspended solids (TSS), using a submerged flight conveyor (SFC), or similar tank-based ash dewatering system and then reuse the water for bottom ash sluicing. An alternative compliance strategy previously would be to continue managing the bottom ash sluice waters in a portion of the current ash pond system, and to continue discharging pond effluent to Lick Creek. A sub-option is to add treatment chemicals to the current ash pond system to improve removal of TSS and trace metals and minimize NPDES compliance risks. It should be noted that in the proposed compliance strategy a portion of the current ash pond system is to be converted to a new lined pond with chemical addition ("Enhanced Pond") for treating the Other Wastewater group (such as cooling tower blowdown).

Compliance Options

A tank-based ash compliance strategy would include: wet sluicing bottom and economizer ash to SFC-type treatment, pumps, pipes to carry the recycle water back to the power block, replacement of existing pipes to ones that are hardened to resist the abrasive nature of the recycle water, a building to cover the ash dewatering system, and at Petersburg an effluent tank with mixer (not needed at Harding because will use dewatering system volume for pump suction instead of needing a new tank). Costs also include the associated piping, electrical, and foundation work. There would be no surface water discharge from the system. Operating costs would include energy and maintenance for the ash dewatering system, and the cost of ash disposal or reuse.

The alternative compliance strategy options would include continuing to sluice the bottom ash waters to the current pond systems. At Petersburg bottom ash is sluiced to the pond system via a ditch, and water ultimately flows to the Finishing Pond and then to Lick Creek via Outfall No. 001. At Harding Street bottom ash is sluiced to Pond 1, then flows to Pond 2A/2B, then 4A/4B, then to Pond 3, which then discharges to Lick Creek via Outfall No. 006. If this bottom ash option were chosen, the overall compliance strategy would include: FGD ZLD, fly ash water ZLD (dry ash handling), bottom ash treated in ponds, and Other Water treated with chemical addition and precipitation and then discharged; with the treated bottom ash water and treated Other Water combined before discharge to Lick Creek post final pond effluent discharge.

The option of adding treatment chemicals to the current ash pond system would include addition of treatment chemicals (organosulfide and polymer) and aeration for mixing into the pipe carrying water into the final pond (Petersburg's Finishing Pond and Harding Street's Pond 3). This would improve removal of soluble and small particle pollutants. Such a system would include chemical storage totes, chemical feed pumps, associated electrical and instrumentation equipment, and building. Both sites will also need dredging to ensure adequate room is maintained to settle solids out. This chemical feed system to the ash ponds could also be used to help

[7] The bottom ash waters include economizer ash and air heater sluicing. It does not include air heater or precipitator washes, which will be handled with the Other Water group in an enhanced pond.

both stations meet the Interim limits already in place. Both stations have had occurrences of non-compliance with the iron (Harding Street and Petersburg), interim copper (Harding) limits. Petersburg has also had levels of Total Residual Chlorine that have triggered increased monitoring and increased risk with potential future limits on TRC. The chemical feed system to the ash ponds is described in more detail in the Cost section below, and in the memos: "*Indianapolis Power & Light Company (IPL) – Harding Street Generating Station – Copper and Iron Compliance*" dated January 2, 2014" and *"Indianapolis Power & Light Company (IPL) – Petersburg Generating Station - Iron Compliance"* dated October 1, 2013 and the "Petersburg Total Residual Chlorine Evaluation" dated January 8, 2014. It is likely that at Petersburg such a chemical feed system to ponds will be needed during the sequencing of construction of the NPDES compliance system (in 2016-2017) because during that time the ash pond will be smaller than it currently is, reducing effectiveness in settling. It is also likely that a chemical feed system will be needed to help meet compliance with permit limits already in effect (iron and copper).

It should be noted that we do not recommend addition of an iron salt solution as part of this feed system (such as is in the Other Water enhanced pond system). This is because iron addition needs reaction tanks to be effective (whereas the organosulfide and polymer being recommended here can be effective when added into the flow without a mix tank). Adding the mix tanks and pH control needed to make iron addition work would make this several times more expensive. Additionally, adding iron salts would risk exasperating the on-going challenges with iron compliance in the pond effluent as while most of the iron will precipitate from solution and settle out, some added iron may carry through the pond to the effluent.

Potential Risk and Other Considerations

Compliance Strategy of Tank-Based Option

The current compliance strategy (treatment and recycle of ash water) has no compliance risk as it eliminates discharge and the use of ponds for the CCR material.

Compliance Strategy of Using Existing Ponds

The alternative compliance strategy options have risk with NPDES compliance and potential risk related to future regulatory compliance requirements.

Compliance Risk

Process Wastewater Discharge

Discharging bottom and economizer ash has the risk of causing non-compliance with the NPDES permits' Final limits on trace pollutants in Petersburg Outfall 001 and Harding Street Outfall 006. This risk can be evaluated by first using available data on bottom ash water and economizer water, as shown in Tables 1 and 2. Then it must be considered that this bottom ash water would be mixed with Other Water stream treated by enhanced pond. Based on CH2M HILL experience with bottom ash wastewater at other facilities, bottom ash wastewater is consistently low in soluble metals. This information was also used to help evaluate risk.

We recommend that chemical addition of organosulfide and polymer be used in the ash pond, as this will be needed to lower the compliance risk.

Harding Street had only one parameter in one sample out of four samples of soluble metals in bottom ash water above one-half the discharge limit. This was selenium, present just below the limit in one sample. Bottom ash does not typically leach much selenium. And Other Water *should* have lower selenium and help dilute selenium in the Bottom Ash Water, though this is hard to verify because Other Water data affected by regenerant waste and fly ash to Unit 7 sump. Because of the limited data, discharging bottom ash water at Harding Street is considered to have **moderate** risk of selenium non-compliance until actual water from Unit 7 sump can prove how much selenium dilution there will be. It is problematic to predict selenium concentrations until the change to Unit 7 sump are made. Though this option presents the least cost option, it does present a higher non-compliance risk which may potentially result in non-conformance events and potential penalties at a cost of $25,000 day/event. CH2M HILL sees this probability of non-compliance as low. This is based on the limited historical data reviewed at the time of this report which showed only 16% (1 of 6 data points) of bottom ash water samples with a detection above ½ the discharge limit of any parameter (which should be further mitigated by planned chemical addition), anticipated treatment performance, the fact that this ash water will mix with Other Water (treated in enhanced pond) which would further lower risk, and CH2M HILL experience with similar wastewater at other plants.

Petersburg had one sample out of 10 of the bottom ash and two of three economizer ash samples with one or more parameters above one-half of the NPDES limits for cadmium, mercury or selenium (Table 2). There is roughly equal bottom ash and other water flows. The Other Water appears able to dilute these to below discharge limits, after Other Water is treated through enhanced ponds. For example, the predicted Other Water selenium concentration is 0.003 mg/L, significantly below the 0.033 mg/L limit. We recommend that chemical addition of organosulfide and polymer be used in the ash pond, as this should lower the compliance risk of cadmium and mercury to **low**. Though this option presents the least cost option, it does present a higher non-compliance risk which may potentially result in non-conformance events and potential penalties at a cost of $25,000 day/event. CH2M HILL sees this probability of non-compliance as low. This is based on the limited historical data reviewed at the time of this report which showed only 20% of (3 of 15 data points) ash water samples with a detection above ½ the discharge limit of any parameter (which should be further mitigated by planned chemical addition), anticipated treatment performance, the fact that this ash water will mix with Other Water (treated in enhanced pond) which would further lower risk, and CH2M HILL experience with similar wastewater at other plants. Without chemical addition we recommend this risk still be considered **moderate**.

Factors to consider when evaluating the data to predict compliance:

- Increases risk: We evaluated filtered sample results (so that remaining metals are "soluble", or, more accurately, soluble and solids passing a 0.45-micron filter). This approach assumes that settling in ponds will produce water with pollutants at same levels as filtering achieves. Settling is likely not as effective as filtering, as some particulate (including trace metals) can pass through settling ponds. However, the trace pollutant particulate contribution in pond effluent is typically low compared to the soluble contribution so this is considered a small increase in risk.
- Increases risk: trace pollutants in fly ash, FGD solids, and other waste solids that have already settled out in the ash ponds may be reintroduced into ash water. This could be by solids being re-entrained in the water column, or by dissolution of pollutants from solid to liquid. This risk could be lowered by adding liners to the existing ponds, but it is CH2M HILL's considered opinion that the risk of this causing non-compliance to be low because: bottom ash should form a relatively insoluble, heavy layer of solids over the older solids, and because chemical addition (if used) can help precipitate back out of solution metals if they are dissolved from older solids.
- Decreases risk: The data considered for Other Water group is based on the soluble concentrations of pollutants in untreated water. Because the Other Water will be treated by enhanced pond treatment before discharge, which should precipitate some soluble metals out of solution, the actual pollutant contribution from Other Water should be lower, thereby lowering the risk of non-compliance.
- Decreases risk: Similarly, if chemicals are added to the bottom ash water, it should further lower concentrations of trace pollutants, thereby further lowering the risk of non-compliance.
- Decreases risk: At Harding Street the Other Water data still includes Unit 7 sump waste as impacted by water treatment regenerant waste. The Unit 7 sump waste pollutant contribution will decrease with the planned reduction of the regenerant waste stream.
- Decreases risk (possibly): It may be possible that past bottom ash samples were contaminated by fly ash water, since the two types of sluice water are carried in same pipe at Petersburg and Harding.

Stormwater Compliance

Keeping bottom ash water to existing ponds will continue to have issue of CCP Haul Trucks tracking onto plant exit roads.

Pond Integrity Risk

Keeping bottom ash water to existing ponds will continue to have risk of pond levee stability. The cost estimate (Table 3) includes cost to do upgrades to pond levees needed to keep them in service for the interim period considered.

Consideration of Potential Future Regulations

It is expected that the CCR Rule will ban the use of unlined ponds for CCR material. This ban was in all options of the draft CCR Rule issued in 2010, and current industry insight is that the final CCR rule will still include such a ban. Therefore the alternative approach of using the current ponds would need to be replaced with a lined pond-based or dewatering system-based treatment by the compliance date of the CCR Rule. There is also a possibility at Petersburg that the facility may not be able to continue operation of the pond system due to its location in a seismic zone area/fault line.

It is also possible that the ELG will ban discharge of bottom ash water. This was one of the two of EPA's "preferred options for existing sources" for bottom ash water in the proposed ELG published in 2013. The other option allowed for continued pond treatment. Using ponds will not work with closed-loop recycle of water due to addition of rainwater to the ponds in excess of the amount removed by evaporation or loss with the dewatered ash. Therefore, if the final ELG bans bottom ash transport water discharge, the system based on using the current ponds would need to be replaced with a dewatering system and closed-loop ash sluicing system by the compliance date of the ELG rule, as applied through the stations' NPDES permits.

Relatively low capital cost associated with treatment in the existing pond allows IPL to, at a minimum, delay additional cost until more certainty exists around the outcome and timing of potential future regulations.

TABLE 1
Harding Street Bottom Ash Water Quality

Sample Date	NPDES Limit on Total Metals	Unit 7 Bottom Ash Water					
		12/8/11	4/16/12	5/30/12	9/26/12	12/19/12	1/3/13
Filtered Samples							
Copper, Filtered (mg/L as Cu)	0.025	No data	No data	< 0.05	0.0074	0.0082	0.0079
Iron, Filtered (mg/L as Fe)	1	No data	No data	0.11	0.093	0.16	0.18
Cadmium, Filtered (mg/L as Cd)	0.0022	No data	No data	< 0.01	< 0.00006	0.00019	< 0.0005
Selenium, Filtered (mg/L as Se)	0.029	No data	No data	< 0.1	0.026	0.0032	0.0013
Mercury, Filtered (ng/L as Hg)	12	No data	No data	No data	1.6	2.8	1.8
Total Metals (provided as reference, most particulate metal expected to be removed by settling)							
Copper (mg/L as Cu)		< 0.05	< 0.05	0.080	0.053	0.016	0.010
Iron (mg/L as Fe)		6.1	4.9	9.8	7.2	2.8	0.54
Arsenic (mg/L as As)		< 0.1	0.1	< 0.1	0.017	0.0055	0.0033
Cadmium (mg/L as Cd)		< 0.01	< 0.01	< 0.01	< 0.00006	0.00024	< 0.0005
Chromium (mg/L as Cr)		< 0.02	< 0.02	0.020	0.014	0.0037	0.0014
Selenium (mg/L as Se)		< 0.1	< 0.1	< 0.1	0.028	0.0033	0.0014
Mercury (ng/L as Hg)		No data	No data	No data	43	10	5

TABLE 2
Petersburg Bottom Ash and Economizer Ash Water Quality

	001 Limits on Total Metals		Unit 1 Bottom Ash			Unit 2 Bottom Ash			Unit 3 Bottom Ash			Unit 4 Bottom Ash			Unit 4 Economizer		
	AML	MDL	10/5/11	12/14/11	5/1/12	10/5/11	12/14/11	5/1/12	10/5/11	12/14/11	5/1/12	10/5/11	12/14/11	5/1/12	10/3/12	10/15/12	10/30/12
Filtered Samples																	
Arsenic, Filtered, as As, mg/L	report	report	No data	No data	<1	No data	No data	<0.9	No data	No data	No data	No data	No data	<1	0.00781	0.00352 J	0.00551
Boron, Filtered, as B, mg/L	report	report	No data	No data	1.2	No data	No data	0.65	No data	No data	No data	No data	No data	4.9	4.43	4.66	1.53
Cadmium, Filtered, as Cd, mg/L	0.002	0.0035	0.000189	<0.0002	0.000083	0.000073	<0.0002	0.000069	0.000124	0.00212	No data	No data	0.000764	0.000353	0.00013 J	0.00346 J	<0.005
Chromium, Filtered, as Cr, mg/L	0.19	0.19	No data	No data	<0.2	No data	No data	<0.18	No data	No data	No data	No data	No data	<0.2	0.00017 J	0.00236 J	0.00115 J
Nickel, Filtered, as Ni, mg/L	0.10	0.24	No data	No data	<0.1	No data	No data	<0.09	No data	No data	No data	No data	No data	<0.1	No data	No data	0.02
Copper, Filtered, as Cu, mg/L	0.022	0.039	0.00103	0.0016	<0.00067	<0.00039	<0.00140	<0.00067	<0.00039	<0.00140	No data	No data	0.00123	<0.00067	0.00473	0.00808	0.00794
Iron, Filtered, as Fe, mg/L	1	1	No data	No data	<0.5	No data	No data	<0.45	No data	No data	No data	No data	No data	<0.5	0.01 J	<1	0.02 J
Selenium, Filtered, as Se, mg/L	0.033	0.057	0.00234	0.00101	0.00355	0.00423	0.00087	0.00238	0.00835	0.0283	No data	No data	0.0121	0.0121	0.0201	0.0147	0.00484
Mercury, Filtered, ng/L	12	20	0.9	3.7	2.6	1.2	2.8	2.6	1.2	12.3	No data	No data	<5.1	<1.8	No data	*<100*	No data
Total Metals (provided as reference, most particulate metal expected to be removed by settling)																	
Arsenic, Total, as As, mg/L			<0.1	<0.1	<1	0.1	<0.1	<1	<0.1	<0.1	No data	No data	<1	<1	0.138	0.342	0.506
Boron, as B, mg/L			0.36	0.33	1.5	1.1	0.54	1.3	2.2	7.9	No data	No data	6.2	4.9	4.76	5.69	6.1
Cadmium, as Cd, mg/L			0.000258	0.00048	0.00145	0.00269	<0.00029	0.000926	0.00146	0.00242	No data	No data	0.0025	0.00241	0.00498	0.0119	0.00895
Chromium, Total, as Cr, mg/L			<0.02	<0.02	0.55	0.04	<0.02	0.53	0.07	<0.02	No data	No data	<0.2	0.2	0.0258	0.0616	0.11
Copper, Total, as Cu, mg/L			0.00858	0.0189	0.0554	0.238	0.0173	0.0856	0.203	0.0313	No data	No data	0.132	0.100	0.0414	0.125	0.191
Iron, Total, as Fe, mg/L			7.5	9.3	75	51.0	8.2	159	63.0	17.4	No data	No data	74	32	15.5	30.5	45.8
Selenium, Total, as Se, mg/L			0.00180	0.00260	0.00508	0.00532	<0.00260	0.00656	0.00866	0.0266	No data	No data	0.0195	0.016	0.0157	0.0171	0.0171
Mercury, Total, ng/L			9.2	<90	<77	100	90	161	66.4	141	No data	No data	203	<77	89 J	36 J	No data

Notes:

AML = Average Monthly Limit. MDL = Maximum Daily Limit.

J-flagged values are estimated concentrations detected above the method detection limit DL but below the laboratory report limit. Values not detected above the DL are presented as < DL.
Red highlighted cells indicate values that are over one-half of the monthly average limits. For non-detect values, the detection limit is used for comparison with the permit limit.

Source: GE's 2012 Water Management Study.

Cost Comparison

The tank-based and pond-based compliance strategy costs are shown in Table 3.

Estimating How Long Costs may be Deferred[8]

The alternative compliance strategy options have lower costs, but there is a moderate to high likelihood that closed loop bottom ash sluicing may be needed in the near-term future for purposes of compliance with future federal regulations. Therefore, the alternative compliance strategy options are likely a cost-deferment opportunity, rather than a cost-saving opportunity. However, at this time the NPDES WWT project team cannot predict future compliance needs associated with future proposed federal regulations, which may drive this technology, as these regulations were not finalized at the time of this review. How long the cost may be deferred is uncertain as well because when compliance with the CCR or steam electric generating ELG rules is required is not yet known. Relatively low capital cost associated with treatment in the existing pond allows IPL to, at a minimum, delay additional cost until more certainty exists around the outcome and timing of potential future regulations.

- The best available estimate is that the CCR rule will be published in late-2014 and require pond compliance in 5 to 7 years, meaning by 2019-2021. This would mean 2 to 4 years of possible deferring the ash dewatering system after the NPDES compliance strategy deadline of 2017.
- ELG compliance would likely be in the next NPDES permit that comes after the effective date of the final ELG. Per the proposed ELG this will mean July 2017, so the next permit IPL gets (October 2017) likely would include ELG limits, which may include a ban on bottom ash discharge. This would mean the ash dewatering system may have no delay if this potential compliance option is chosen by EPA in the final ELG regulation. However, if the ELG is delayed it may mean that this July 2017 date slides backwards and IPL permits would not get ELG requirements until later.

Additional Cost in Building the Ash Dewatering System (Submerged Flight Conveyance System with Recycle) after Main NPDES Compliance System

If the pond-based alternative approach is used initially and then the ash dewatering treatment system is built later due to other regulatory compliance needs, there will be some additional cost above doing the dewatering-based option initially depending on the timing associated with potential future regulatory compliance needs. The additional cost of this two-phased approach would include the cost of doing two projects rather than one (extra engineering, procurement, startup, and contractor mobilization**)**. We have estimated this extra cost as 5% of the second phase direct cost (the ash dewatering) for remobilizing, based on construction industry rules-of-thumb. We then also included $500,000 per plant for the additional engineering, procurement, and construction management.

Cost of Chemical Addition to Ash Ponds

The cost of chemical addition may be an additional cost beyond what is needed for phase-one compliance if it is determined that Ash dewatering-based treatment is needed to meet future regulation compliance. The cost is roughly $500,000 per plant to build a chemical feed system. Petersburg will also need some initial dredging (a possible additional cost beyond what is shown in Table 3 below) to ensure adequate room to settle solids out. However, it should be noted that this chemical addition is needed for interim NPDES compliance needs due to ongoing NPDES compliance needs as addressed previously regardless of the final NPDES compliance strategy selection.

The assumed elements of the chemical addition system to the ponds are described in the Iron memo of January 2, 2014. They include:

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[8] Predicting the impact of the aforementioned regulations is speculative as it dependent on the final rule compliance needs, final rule timing, and how IDEM manages permits and/or rulemaking to incorporate these requirements.

- Aeration will be used for mixing where the polymer is added. Two blowers will be used, so that one offline spare can be maintained. A variable frequency drive was included in the blower to allow reducing the air flow for polymer addition.
- Two polymer blending systems were included for polymer dilution, including two 10-gpm submersible sump pumps (one standby, one online) to convey dilution water from the finishing pond outlet to the polymer blending system. The dilution water flow rate was calculated based on an influent flow rate and a polymer dose of 5 ppm, and dilution to 1 percent product.
- Two 10-gpm cartridge filters were included (1 standby, 1 online) to remove particles greater than 1 micron from the dilution water. Pressure drop will be monitored across the filters to determine when to change them.
- A 10 ft x 20 ft x 10 ft chemical storage building, with grading in floor and containment built in, was included. It was sized to hold two stackable totes at 1,000 liters each, two polymer blending systems, a cartridge filter, a motor control center, and other electrical equipment.
- Costs for a platform to access the conveyance pipes between Pond 4B and Pond 3 were included. This includes a 10 ft x 6 ft ramp, a 15 ft x 6 ft platform, 25 feet of aluminum handrail (for both the ramp and the platform), and an allowance of 60 percent of handrail and grating costs for columns and structural frame.
- 1-inch diameter piping will be installed between the chemical storage building and Outfall 006 to convey water from the outlet to the cartridge filter and polymer makeup system.
- Two organosulfide metering pumps were included (1 standby, 1 online) for organosulfide addition in the cooling tower blowdown effluent.
- Operating costs of this option include chemicals, energy, equipment maintenance, and the on-going cost of removing bottom ash from the pond system (e.g., dredging to Pond 2 at Harding Street).

TABLE 3
Costs and Risks for Just the Bottom Ash Compliance Portion of the Compliance Strategy

	Tank-Based Dewatering and Reuse	**Alternative Strategy – Including Cost of Polymer and Organosulfide Addition into Ash Ponds**
Harding Street Costs		
Short-term (by 2017) Capital Cost	$26,000,000	$500,000 for chemical addition system (See Note 1)
Total capital cost	$26,000,000 (Note that a chemical addition system may be installed at ash ponds to mitigate risk with *interim* limits, this cost is not included here)	$26,000,000 plus $525,000 plus $1,300,000 extra costs for doing the ash dewatering-based as a later phase
Annual O&M Cost	$470,000/year for energy and maintenance.	$40,000/year to continue dredging ash ($2/ton estimate) plus $350,000/year for energy, maintenance and chemicals
Summary compared to Dewatering	N/A	Defers/eliminates roughly $26MM capex and an increase of $0.08MM/year O&M cost. Adds $1.3MM due to building in two phases. See Note 3.
Petersburg Costs		
Short-term (by 2017) Capital Cost	$43,000,000	$500,000 for chemical addition system (See Note 1) plus $700,000 for pond stabilization (per SCS) = $1,200,000
Total capital cost	$43,000,000 (Note that a chemical addition system may be installed at ash ponds to mitigate risk with *interim* limits, this cost is not included here)	$43,000,000 plus $1,200,000 plus $1,600,00 extra costs for doing the ash dewatering-based as a later phase
Annual O&M Cost	$800,000/year for energy and maintenance See Note 2	$135,000/year for energy, maintenance and chemicals Cost of dredging roughly 50,000 tons/year (which gets into pond past the IPL excavators) at $12/ton to dredge then transport & disposal = $600,000/year. Total = $735,000/year.
Summary compared to Dewatering	N/A	Defers/eliminates roughly $43MM capex. Adds $1.6MM due to two phases. See Note 3. O&M costs of two options are similar.

Notes:

Costs are considered Class 5 estimates.

[1] Also some cost to make overall wastewater treatment system pipe racks large enough to take the future pipelines to and from bottom ash treatment. This is not considered a significant cost increase.

[2] Assume that in tank-based option that an alternative for stockpiling ash in pond area will be found, so that the approach of stockpiling and then selling some of ash can continue. This will add small capital cost, but within the rounding to nearest million used.

[3] Note that to meet interim limits a chemical feed system to the ash pond may be built regardless of final NPDES strategy. System could be abandoned once ash pond closed.

TECHNICAL MEMORANDUM

CH2MHILL®

Indianapolis Power & Light Company (IPL) Petersburg Generating Station – Evaluation of Wastewater Treatment Scenarios for Closing or Converting Units to Gas

PREPARED FOR:	David Kehres/IPL
PREPARED BY:	CH2M HILL
DATE:	September 15, 2014

This Technical Memorandum is an update to the July 7, 2014 version. This update considers cost revisions from June 30, 2014 that were made to the baseline case (no units are closed or converted to natural gas) but also apply to the 9 scenarios described below. All other aspects of the cost estimates are unchanged.

IPL requested that CH2M HILL prepare rough cost impacts for the wastewater treatment systems that would likely result if any one of the coal-fired units at the Petersburg Station were to be either closed or converted to natural gas or if both Units 1 and 2 were to be closed. This resulted in 9 scenarios. Four of the scenarios are for closing any one of the units individually, one scenario is for closing both Units 1 and 2, and four scenarios are for converting any one of the units to gas.

CH2M HILL performed these analyses using the sizing and costing model developed in June to prepare a Class 4 estimate. This model includes FGD treatment for recycle and ZLD evaporation, Bottom Ash treatment using chemical addition in the existing ash pond, and tank-based treatment for Other Wastewater. This model was used because it was straight-forward to resize each of the treatment systems and have cost information directly generated.

We evaluated the CAPEX and OPEX impacts on the ZLD system with recycle only. We did not reduce the size of the Other Wastewater treatment system (tank-based system), for any of the scenarios because the reduction in cooling tower blowdown resulting from closure of a unit would be a small portion of the total flow. The Other Wastewater flow generally includes cooling tower blowdown from all operating units (for both gas-fired and coal fired units), stormwater, and coal pile runoff. We did account for reduced OPEX costs for the Other Wastewater treatment system for each scenario where a unit is shut down. We also adjusted the OPEX costs for the reduction in bottom ash handling and disposal. Note that closing Units 1 and 2 would result in only needing two bottom ash dewatering units (BADUs) instead of three; this cost saving is not included in the cost estimate.

Scenarios involving retiring or converting Unit 1 or Unit 3: By closing or converting either Unit 1 or Unit 3, you are left with two units (2 and 4) that can receive recycle water. This enables the cost savings from smaller treatment systems to be realized without having to increase storage capacity to handle flows when one unit is out of service for maintenance.

Scenarios involving retiring or converting Unit 2: Eliminating or converting Unit 2 actually resulted in a slight increase in project cost, as it does not significantly reduce wastewater flow, and when Unit 4 is out of service, there is no unit to receive recycle water. This resulted in an increase in evaporator size that more than offset the savings from a slightly reduced recycle treatment system size.

Scenarios involving retiring or converting Unit 4: For the elimination or conversion of Unit 4 we considered two treatment alternatives; scenarios 4a and 9a included providing smaller recycle and ZLD systems, and scenarios 4b and 9b eliminated recycle and used a larger ZLD system. The smaller treatment system option (4a and 9a) resulted in a significant increase in equalization storage, since we needed to accommodate 60 days of Unit 2 shutdown, which is the only remaining unit that can utilize recycle water. This additional equalization requirement reduced savings for this alternative. Eliminating any of the other units did not have a significant reduction in the volume of water treated, although eliminating or converting Unit 1 or Unit 3 resulted in significant savings as described above.

Scenario 5 involving retiring Units 1 and 2: Eliminating these two units results in a reduction in the FGD wastewater flows, due to elimination of the discharge from these units, as well as reducing the blowdown from the gypsum sumps at the gypsum dewatering facility. Since the Units 1 and 2 dewatering system will no longer be needed, the associated tanks would be available, eliminating the need for a new dewatering storage tank and pumps. Likewise the need for a new limestone ball mill tank is eliminated. Reduced FGD wastewater flow results in reduction in size of FGD recycle wastewater treatment and ZLD systems. Other Wastewater treatment is not changed, as Unit 1 and 2 do not have cooling tower blowdown, and closing these units does not reduce stormwater peak flow, both of which represent the main peak flows for which the Other Wastewater treatment system is designed. Closing Units 1 and 2 would also result in reducing the number of BADUs required from three to two. We did not include this cost saving in our analysis, as this cost was not included in our baseline, but the reduction in the number of BADUs needed is a benefit of closing two units.

The attached Tables provide summaries of the cost impacts to the wastewater treatment plant CAPEX and OPEX from the 9 scenarios – 4 related to closing any one of the coal fired units, 1 related to closing two of the units, and 4 related to converting any one of the units to gas.

IPL - Petersburg Station - Wastewater Treatment Plant
Cost Analysis for Various Scenarios
Scenarios Eliminating (Retiring) Various Units

Scenario[1]	Total Design FGD Flow, gpm	Evap. Design Capacity, gpm	Evap. Capacity, gpm (each train)	Design Recycle Capacity, gpm	Recycle Capacity, gpm (each train)	Storage Provided (MG)	CAPEX ($MM)	CAPEX Savings ($MM)	OPEX Costs ($MM/yr)	OPEX Savings ($MM/yr)	Annualized Cost ($MM/yr)	Annualized Savings ($MM/yr)	NPV ($MM)	NPV Savings ($MM)
Current ZLD with recycle	647	250	150	391	391	2.0	177	Base case	10.2	Base case	36.9	Base case	245	Base case
1. Eliminate Unit 1, ZLD with recycle	607	192	115	415	415	1.7	168	**9**	8.8	**1.4**	34.1	**2.7**	226	**18**
2. Eliminate Unit 2, ZLD with recycle U4	587	267	160	320	320	2.0	178	**-1**	9.5	**0.7**	36.3	**0.5**	241	**4**
3. Eliminate Unit 3, ZLD with recycle	577	174	104	403	403	1.7	166	**11**	8.1	**2.1**	33.1	**3.8**	220	**25**
4a. Eliminate Unit 4, ZLD with recycle U2	255	79	47	176	176	10.1	168	**9**	6.8	**3.4**	32.1	**4.7**	213	**32**
4b. Eliminate Unit 4, ZLD with no recycle	255	255	153	0	0	1.7	174	**3**	9.7	**0.5**	35.9	**0.9**	238	**6**
5. Eliminate Units 1 and 2, ZLD with recycle U4	505	185	111	320	320	1.7	158	**19**	7.8	**2.4**	31.6	**5.3**	210	**35**

Notes:

1. File PB_Costs_FGD and tank-based Other_2014_0630.xlsx was used as the basis for the current costs and evaluating the other scenarios. This was prepared as a Class 4 estimate in accordance with the Association for the Advancement of Cost Engineering International.
2. Evaporator sizing was based on providing two trains, each with 60 percent of the design capacity. Recycle treatment systems were based on providing two trains, each with 100 percent of the design capacity.
3. Costs include other, ash and "other project related costs". Ash cost estimates were reduced proportionately to the relative size of the Unit (MW) being eliminated.
4. Costs for the options only included modifying major equipment, including: equalization tanks, clarifiers, evaporator systems, and filter presses.
5. Chloride levels in the scrubbers were evaluated, but the effect of water chemistry changes on brine production or chemical demand were not considered.
6. Evaporator costs for all cases do not include latest Aquatech prices.
7. The elimination or conversion to gas of Unit 4 were the only options where the filter press sizes or numbers were reduced.
8. The number and cost of piles were adjusted for all scenarios.
9. Net Present Value (NPV) based on 10 years of O&M based on 8.25 percent interst rate plus Total Installed Cost (TIC).

IPL - Petersburg Station - Wastewater Treatment Plant
Cost Analysis for Various Scenarios
Scenarios Converting Any One Unit to Natural Gas

Scenario[1]	Total Design FGD Flow, gpm	Evap. Design Capacity, gpm	Evap. Capacity, gpm (each train)	Design Recycle Capacity, gpm	Recycle Capacity, gpm (each train)	Storage Provided (MG)	CAPEX ($MM)	CAPEX Savings ($MM)	OPEX Costs ($MM/yr)	OPEX Savings ($MM/yr)	Annualized Cost ($MM/yr)	Annualized Savings ($MM/yr)	NPV ($MM)	NPV Savings ($MM)
Current ZLD with recycle	647	250	150	391	391	2.0	177	Base case	10.2	Base case	36.9	Base case	245	Base case
6. Convert Unit 1, ZLD with recycle	607	192	115	415	415	1.7	168	**9**	9.1	**1.1**	34.4	**2.4**	228	**16**
7. Convert Unit 2, ZLD with recycle U4	587	267	160	320	320	2.0	178	**-1**	10.0	**0.2**	36.8	**0.0**	244	**0**
8. Convert Unit 3, ZLD with recycle	577	174	104	403	403	1.7	166	**11**	8.7	**1.5**	33.7	**3.2**	224	**21**
9a. Convert Unit 4, ZLD with recycle U2	255	79	47	176	176	10.1	168	**9**	7.4	**2.8**	32.7	**4.1**	217	**28**
9b. Convert Unit 4, ZLD with no recycle	255	255	153	0	0	1.7	174	**3**	10.3	**-0.1**	36.5	**0.3**	242	**2**

Notes:

1. File PB_Costs_FGD and tank-based Other_2014_0630.xlsx was used as the basis for the current costs and evaluating the other scenarios. This was prepared as a Class 4 estimate in accordance with the Association for the Advancement of Cost Engineering International.
2. Evaporator sizing was based on providing two trains, each with 60 percent of the design capacity. Recycle treatment systems were based on providing two trains , each with 100 percent of the design capacity.
3. Costs include other, ash and "other project related costs". Ash cost estimates were reduced proportionately to the relative size of the Unit (MW) being eliminated.
4. Costs for the options only included modifying major equipment, including: equalization tanks, clarifiers, evaporator systems, and filter presses.
5. Chloride levels in the scrubbers were evaluated, but the effect of water chemistry changes on brine production or chemical demand were not considered.
6. Evaporator costs for all cases do not include latest Aquatech prices.
7. The elimination or conversion to gas of Unit 4 were the only options where the filter press sizes or numbers were reduced.
8. The number and cost of piles were adjusted for all scenarios.
9. Net Present Value (NPV) based on 10 years of O&M based on 8.25 percent interst rate plus Total Installed Cost (TIC).